

INDIAN AGRICULTURAL  
RESEARCH INSTITUTE, NEW DELHI.

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19 MAR 1953

# BULLETIN OF THE IMPERIAL INSTITUTE

A RECORD OF PROGRESS RELATING TO  
AGRICULTURAL, MINERAL AND OTHER  
INDUSTRIES, WITH SPECIAL REFERENCE TO  
THE UTILISATION OF THE RAW MATERIALS  
OF THE DOMINIONS, COLONIES AND INDIA



VOL. XXVII. 1929

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# BULLETIN OF THE IMPERIAL INSTITUTE

VOL. XXVII. 1929

## CONTENTS

### THE IMPERIAL INSTITUTE

	PAGE
GENERAL INFORMATION . . . . .	i
TRUSTEES AND BOARD OF GOVERNORS . . . . .	v
ADVISORY COUNCILS . . . . .	vii
STAFF . . . . .	ix

### REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

NEW MATERIALS FOR THE MANUFACTURE OF ARTIFICIAL SILK . . . . .	1
FRUITS AND SEEDS OF <i>ALBURITES FORDII</i> FROM KENYA COLONY . . . . .	10
FRUITS AND SEEDS OF <i>HYDNOCARPUS WOODII</i> FROM NORTH BORNEO . . . . .	12
CAUSES OF VARIATION IN PLASTICITY OF PLANTATION RUBBER . . . . .	16
BRICK AND TILE CLAYS FROM ISHIAGO, NIGERIA . . . . .	27
WOOL IN NEW ZEALAND . . . . .	147
I. MEMORANDUM ON DETERIORATION IN SHEEP BREEDING IN NEW ZEALAND. By SIR FREDERIC A. AYKROYD, BART. . . . .	148
II. MEMORANDUM ON PHYSICAL ANALYSIS OF THE ROMNEY, CORRIEDALE AND ROMNEY-CORRIEDALE CROSS-BRED FLEECES. By S. G. BARKER, Ph.D., D.I.C., F.Inst.P., F.R.S.E., and C. G. WINSON, B.Sc. ( <i>illustrated</i> ) . . . . .	150

17244

## CONTENTS

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE <i>-continued-</i>	131
BRICK AND TILE CLAYS FROM THE SUDAN . . . . .	135
RECENT INVESTIGATIONS OF OIL SEEDS . . . . .	137
PATCHOULI LEAVES FROM SEYCHELLES . . . . .	139
SISAL BOLES (STUMPS) AND POLES FROM KENYA COLONY AS SOURCES OF PAPER-PULP . . . . .	193
SANIDINE SAND FROM KENYA AS A PUZZUOLANA . . . . .	243
THE COMPOSITION OF SISAL HEMP FROM DIFFERENT COUNTRIES . . . . .	419
<i>EUCALYPTUS SALIGNA</i> AS A SOURCE OF WOOD PULP FOR PAPER AND ARTIFICIAL PULP . . . . .	449
THE TANNING VALUE OF <i>ANOGEISSUS LATIFOLIUS</i> LEAVES . . . . .	452
<i>ALLANBLACKIA STUHLMANNII</i> SEEDS FROM TAN- GANYIKA TERRITORY . . . . .	455
<i>CYMBOPOGON</i> OILS FROM INDIA . . . . .	458

## ARTICLES

TOBACCO GROWING IN SWAZILAND . . . . .	38
RECENT CHANGES IN THE MINING LAWS OF THE EMPIRE . . . . .	46
THE WATTLE BARK INDUSTRY . . . . .	109
NEW CROPS FOR THE COLONIES. ESSENTIAL OIL PLANTS: PEPPERMINT, GERANIUM AND LAVENDER . . . . .	397
CITRUS PRODUCTS . . . . .	312
COCOA: SELECTION AND USE OF HEAVY-YIELDING STRAINS . . . . .	404

## NOTES

TANGANYIKA AGRICULTURAL AND INDUSTRIAL EXHIBITION . . . . .	57
FLAX IN CYPRUS . . . . .	58
CINCHONA CULTIVATION IN INDIA . . . . .	61
THE TRANSPORTATION OF VEGETABLE OILS IN BULK . . . . .	63
FLAX INDUSTRY IN OREGON . . . . .	183

## CONTENTS

### NOTES--*continued.*

	PAGE
REGULATIONS FOR THE EXPORT OF FLAX FROM LITHUANIA . . . . .	187
EMPIRE MARKETING BOARD. REPORTS ON EXPERIMENTAL CONSIGNMENTS OF EMPIRE PRODUCE .	188
GRAPEFRUIT CULTURE IN THE BRITISH WEST INDIES AND BRITISH HONDURAS. . . . .	189
THE WORLD'S PRODUCTION OF ORANGES . . . . .	190
FOREST PRODUCTS RESEARCH IN THE UNITED KINGDOM . . . . .	338
WALNUT WOODS . . . . .	339
THE UTILISATION OF PARA RUBBER SEED . . . . .	340
MANGROVES OF BRITISH MALAYA. . . . .	469
TEAK IN TRINIDAD. . . . .	471
FRENCH COLONIAL TIMBERS. . . . .	472

### RECENT RESEARCH ON EMPIRE PRODUCTS

AGRICULTURE . . . . .	77, 190, 342, 472
FORESTRY . . . . .	376
MINERAL RESOURCES . . . . .	96, 220, 382, 507

### ABSTRACTS OF RECENTLY PUBLISHED LITERATURE ON AGRICULTURE AND FORESTRY

FOODSTUFFS . . . . .	103
OILS AND OIL SEEDS . . . . .	107, 386
ESSENTIAL OILS . . . . .	393
FIBRES . . . . .	III, 396
RESINS . . . . .	112
TANNING MATERIALS . . . . .	114, 400
FORESTRY AND TIMBERS . . . . .	402

## CONTENTS

BIBLIOGRAPHY (PLANT AND ANIMAL PRODUCTS) . . . . .	11
NOTICES OF RECENT LITERATURE . . . . .	11
BOOKS RECEIVED FOR NOTICE . . . . .	11
INDEX . . . . .	11

# LIST OF ILLUSTRATIONS

## WOOL IN NEW ZEALAND

### *Microphotographs of Cross-sections of the Fibre*

PLATE	I.	ROMNEY . . . . .	} following page 160
„	II.	CORRIEDALE . . . . .	
„	III.	ROMNEY-CORRIEDALE . . . . .	



# THE IMPERIAL INSTITUTE

*South Kensington, S.W.7*

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## GENERAL INFORMATION

THE Imperial Institute was founded as the Empire Memorial of the Jubilee of Queen Victoria. Its principal object is to promote the development of the commercial and industrial resources of the Empire.

Under the provisions of the Imperial Institute Act of 1925, the Institute was reorganised and placed under the control of the Department of Overseas Trade. The Parliamentary Secretary of that Department is the responsible Minister and is Chairman of the Board of Governors. This body consists of the High Commissioners of the Dominions and India, representatives of the Colonial Office and of certain other Government Departments, and the Crown Agents for the Colonies, with additional members representing scientific and commercial interests. The Director of the Institute is Lieut.-Gen. Sir William Furse, K.C.B., D.S.O.

On July 1, 1925, the Imperial Mineral Resources Bureau was amalgamated with the Imperial Institute, and the fifteen Advisory Technical Committees of the Bureau were reconstituted in the reorganised Institute.

The technical work of the Institute is carried out by two principal Departments, viz. a Plant and Animal Products Department and a Mineral Resources Department. An Advisory Council for each of these groups of products has been appointed, Sir David Prain, C.M.G., C.I.E., F.R.S., being Chairman of the Plant and Animal Products Council, and Sir Richard Redmayne, K.C.B., Chairman of the Mineral Resources Council.

A number of Advisory Technical Committees consisting of authorities on the various groups of raw materials co-operate in the work of the Institute, in association with the Advisory Councils, and a close touch is maintained with producers, users, merchants and brokers. Valuable help can thus be given by the Institute to persons interested in the development of the resources of raw materials throughout the Empire.

**Intelligence.**—The Institute maintains a special service for dealing with enquiries relating to the sources, production, uses and marketing of raw materials and for collecting and disseminating general and statistical information on these subjects. This service is available for the use of individuals and firms, as well as of Government Departments, without charge.

**Investigations.**—The laboratories of the Institute are specially equipped for the chemical and technical examination of raw materials of all kinds. Full reports are furnished on the composition, uses and value of materials submitted. By its close association with the users of raw materials, the Institute is able to arrange large-scale trials of promising materials when necessary.

Special analyses and investigations are undertaken for firms or private persons in any part of the Empire on payment of appropriate charges. Applications for such investigations should be addressed to the Director.

Investigations on plantation rubber are conducted at the Institute in connection with the Ceylon Rubber Research Scheme.

**Library.**—The Library of the Institute contains a large collection of Colonial, Indian and other works of reference and is regularly supplied with the more important reports and other publications of government departments in Great Britain, the Dominions, Colonies and India, and most foreign countries. More than 500 serial publications, mainly of a scientific or technical character, are also regularly received.

The library is available (free of charge) for the use of

enquirers between the hours of 10 a.m. and 5.30 p.m. on week-days (10 a.m. and 1 p.m. on Saturdays).

**Statistical Section.**—This section is concerned with the collection of statistics for the use of other Departments of the Institute.

**Publications.**—The BULLETIN OF THE IMPERIAL INSTITUTE contains records of the principal investigations conducted for the Dominions, Colonies and India at the Imperial Institute, and special articles, notes and abstracts, chiefly relating to progress in tropical agriculture, the development of mineral resources, and the industrial utilisation of all classes of raw materials. A summary of research work conducted by Government Technical Departments overseas and a selected bibliography of publications received in the library of the Imperial Institute are also included.

Other publications of the Institute include a series of handbooks dealing with the Commercial Resources of the Tropics, with special reference to West Africa ; Reports of the Indian Trade Enquiry ; a series of Selected Reports on Investigations at the Institute ; Monographs dealing with the Mineral Industry of the British Empire and Foreign Countries as well as a statistical series relating thereto ; and a series of volumes on the Mining Laws of the British Empire and Foreign Countries.

**Public Exhibition Galleries.**—These galleries serve as a permanent exhibition of the natural resources, scenery and life of the people of the Dominions, India and the Colonies. It is the only exhibition of the kind in London where all the countries of the Empire are represented under one roof.

A special feature has been made of pictorial representation, which takes the form of illuminated dioramas, transparencies and photographs. These are intended to attract the non-technical visitor and children, and to awaken in them an interest in the raw products which are shown in association with the illustrations. Descriptive labels are attached to all exhibits explaining in simple language their origin, occurrence, methods of cultivation

or preparation, and uses. To render the galleries of further assistance to teachers in the study of Empire geography and development, the exhibits are arranged in a definite sequence on lines suggested by the Advisory Education Committee of the Imperial Institute. Lectures and demonstrations in the galleries are given daily to school teachers and school children by the Guide Lecturers.

At the Central Stand which is maintained in the galleries for enquirers, free literature relating to Empire countries and products is distributed, and priced publications and picture postcards are on sale.

In the Exhibition Pavilion, attached to the Galleries, temporary exhibitions of special products are held. The second of these, devoted to Empire timbers, was held during the months of February, March and April, 1928.

The galleries are open free daily from 10 a.m. to 5 p.m. and on Sunday afternoons from 2.30 to 6 p.m.

**Cinema.**—The Empire Marketing Board maintains a Cinema Theatre in the Imperial Institute adjoining the Indian Section in the Exhibition Galleries. The Cinema is equipped with modern projectors, screen, lighting, heating and ventilating systems and has seating accommodation for 400 persons. The cost of this equipment was also borne by the Board. Displays of films illustrating life and industries in the various countries of the Empire are arranged daily at 10.15, 11.35, 2.15 and 3.35 (Sundays 2.45 and 4.15). Special arrangements are made for visits of organised parties from schools and educational institutions. The displays are free.

**Imperial Art Gallery.**—As a result of negotiations with the Royal Commissioners for the Exhibition of 1851, the upper east gallery has been set aside for exhibition of the works of selected artists from all parts of the Empire. The gallery is also utilised for judging and exhibiting the work of candidates for scholarships at the British School at Rome.

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# REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

*Selected from the Reports made to the Dominion, Colonial,  
and Indian Governments*

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## NEW MATERIALS FOR THE MANUFACTURE OF ARTIFICIAL SILK

At the present time the bulk of the cellulose employed in the manufacture of artificial silk by the viscose process is derived from chemical wood-pulp prepared from spruce wood. In view of the rapid expansion of the artificial silk industry, it is obviously desirable that consideration should be given to the possibility of increasing the range of materials available for the manufacture. From this point of view attention has been devoted in recent years in different countries to a consideration of various local woods and fibres, and to by-products, such as bagasse or megasse, the fibrous residue obtained in the manufacture of sugar from the sugar-cane, and the wood of the wattle tree remaining after the tanning bark has been stripped off.

During the past year bagasse, sulphite pulp prepared from Tasmanian stringy-bark, and *Phormium tenax* fibre have been investigated at the Imperial Institute in order to determine their suitability as sources of cellulose for artificial silk, and the results are given in the following pages.

### I. BAGASSE

The bagasse (sugar-cane residue) used in this investigation was forwarded from Trinidad. It was examined as a paper-making material in the first instance, and it will be useful to give the results of the paper-making trials before dealing with its possibilities for artificial silk.

*Paper-making Trials*

The sample consisted of fibrous chips and crushed cane in pieces of irregular size up to 5 in. in length. A large quantity of pithy matter was present, adhering to the fibrous material.

A chemical analysis was carried out on the bagasse as received, without any separation of the pithy matter, with the following results :

	Per cent.
Moisture . . . . .	10.8
Ash . . . . .	1.2
Cellulose in material as received . . . . .	51.2
„ expressed on the moisture-free fibre . . . . .	57.4

The lengths and diameters of the ultimate fibres were as follows :

	Length. mm.	Diameter. mm.
Maximum . . . . .	5.0	0.0508
Minimum . . . . .	0.6	0.0152
Average . . . . .	1.95	0.0264

The crushed cane was reduced to pieces of approximately even size, and treated with caustic soda under conditions similar to those employed commercially for the production of paper pulp. The following results, which are expressed on the material as received, were obtained :

Trial.	Caustic soda used.		Conditions of digestion.		Parts of caustic soda consumed per 100 parts of material.	Yield of dry pulp.	
	Parts per 100 parts of material.	Parts per 100 parts of solution.	Time.	Temp.		Unbleached.	Bleached.
			hours.	° C.		Per cent.	Per cent.
A	20	3	2	140	11.0	52	37
B	20	3	3	140	11.7	48	40

*Trial A.*—The conditions of this experiment were not sufficiently drastic to yield a well digested pulp. The fibrous portion of the cane was only partially attacked by the liquor, and it was necessary to employ a lengthy and drastic beating treatment in order to reduce the insufficiently digested fibre particles to a workable size, with a consequent overbeating of the better digested portion. The pulp furnished a pale brown, opaque, “rattly” paper of excellent strength, which, however, contained a large amount of imperfectly digested fibre.

The pulp bleached fairly readily to a rather dark cream colour, and furnished a paper of "rattly" character and excellent strength. The unreduced fibre particles were not affected by the bleaching treatment, but a large proportion of the cellular matter was attacked by the bleaching solution, thus causing a considerable loss in that operation.

*Trial B.*—The conditions of this trial were just sufficient to produce a well digested pulp, which furnished a pale greyish-brown paper of similar character and strength to that obtained in Trial A, but showing less "rattle" and greater freedom from unreduced particles. A number of fibrous specks were noticeable, probably derived from the nodes of the cane. With a light bleaching treatment the pulp furnished a very pale cream-coloured paper of similar character and strength to the unbleached paper. The small specks, however, were only partially affected by the bleaching treatment.

This sample of bagasse from Trinidad furnished a good yield of pulp which was easily bleached and yielded paper of excellent strength, but exhibiting the "rattly" character of paper produced from fibrous material containing pithy matter. By mechanical separation of the pith from the fibrous material it would no doubt be possible to produce paper of very good quality.

It is possible that paper of good quality could be produced from bagasse by the adoption of a fractional digestion process (as applied to bamboo) or by the De Vains chlorination process, which is extensively used for the production of straw pulp of good quality. The latter method would entirely eliminate unreduced fibre particles.

### *Bagasse for Artificial Silk*

Owing to the presence in the material of the pithy matter, which would be unsuitable for use in the preparation of cellulose intended for the manufacture of artificial silk, the material was subjected to mechanical treatment with a view to the separation of pith before digestion.

A. A quantity of the bagasse was treated by light grinding (or rubbing) and sieving to remove the pith. In this manner approximately 33 per cent. of pithy matter

was eliminated. The fibrous material was then treated with caustic soda under conditions similar to those employed commercially for the production of pulp, with the following results, which are expressed on the material as received :

Caustic soda used.		Conditions of digestion.		Parts of caustic soda consumed per 100 parts of material.	Yield of dry bleached pulp.	
Parts per 100 parts of material.	Parts per 100 parts of solution.	Time.	Temp.		On air-dry separated material.	On original material as received.
		<i>hours.</i>	<i>° C.</i>		<i>Per cent.</i>	<i>Per cent.</i>
20	3	4	140	12.25	43.5	20 (approx.)

The conditions of this digestion were sufficient to yield a well reduced pulp which bleached fairly readily to a cream colour. The cellulose obtained was examined chemically as to its suitability for the manufacture of artificial silk, and was found to contain :

Moisture . . . . .	<i>Per cent.</i>
Calculated on the moisture-free material :	
Ash . . . . .	0.22
$\alpha$ -Cellulose . . . . .	78.75

The pulp was thus deficient in  $\alpha$ -cellulose, showing that the original material required further purification.

B. A further quantity of the bagasse was therefore taken and treated as follows :

(1) The air-dried material was freed as far as possible from pith by rubbing and sieving.

(2) The material was then submitted to a preliminary process of fractional digestion as follows :

(a) Boiled with water with continuous agitation, then filtered through a coarse sieve. This operation was repeated. This removed starches, sugars, soluble gums and other water-soluble matter, together with some more finely-divided pith.

(b) Boiled with 1 per cent. caustic soda. The pithy matter attached to the fibres swelled and could be fairly readily separated by agitation. This operation was repeated, and removed resins, fats, waxes, etc., together with pectose.

(c) A further washing in water was given and the material finally freed from almost the whole of the remainder of the pith by a light beating treatment

in the Hollander. The material thus obtained after air-drying contained 6.5 per cent. of moisture, which was approximately the same as the amount present in the original material.

This material, constituting 40 per cent. of the original untreated bagasse, was digested with caustic soda under the conditions given below, with the following results :

Caustic soda used.		Conditions of digestion.		Parts of caustic soda consumed per 100 parts of material.	Treated material.		Original material.	
Parts per 100 parts of material.	Parts per 100 parts of solution.	Time.	Temp.		Yield of dry bleached pulp.		Yield of dry bleached pulp.	
					On air-dry material.	On moisture-free material.	On air-dry material.	On moisture-free material.
		hours.	° C.		Per cent.	Per cent.	Per cent.	Per cent.
20	3	3	140	7.1	63	68	24 (approx.)	26 (approx.)

The pulp, which was fairly long-fibred, bleached readily to a pale cream and when dry could be fairly easily disintegrated by hand.

On examination as to its suitability for the manufacture of artificial silk, the pulp gave the following figures, which are shown in comparison with (a) those recorded for bleached sulphite pulp of quality suitable for this purpose, (b) figures supplied by a manufacturing firm for pulp regularly used by them, and (c) figures recorded for commercial absorbent cotton :

—		Present sample.	Figures recorded for bleached sulphite pulp of satisfactory quality.		Manufacturers' figures for wood pulp for artificial silk.	Figures for absorbent cotton. <sup>1</sup>
			(1)	(2)		
Calculated on dry material.	Moisture . . . per cent.	7.7	8 to 12	10	—	4.34
	Ash . . . per cent.	0.14	0.15 to 0.3	0.1 to 0.4	0.17	0.11
	-Cellulose . . . per cent.	86.1	85 to 89	86 to 89	89.63	87.6
	β-Cellulose . . . per cent.	12.6	—	6 to 8	3.69	12.2
	γ-Cellulose . . . per cent.	1.3	—	3 to 5	6.63	0.12
	Copper number . . .	0.56 <sup>2</sup>	Not over 3	2 to 3	2.47 <sup>2</sup>	1.13 <sup>3</sup>
	Phloroglucinol absorption value per cent.	1.19	—	—	1.03	—
	Soda absorption value . . .	215	—	—	162	—
	Acetone extract per cent.	0.26	0.6 to 0.7	—	—	—

<sup>1</sup> S. A. Mahood and D. E. Cable, "Journ. Indust. Eng. Chem.," 1922, 14, 727.

<sup>2</sup> Braid's Method.

<sup>3</sup> Schwalbe's Method.

The foregoing figures indicate that the bagasse pulp prepared in Experiment B would be quite suitable for the manufacture of artificial silk. The amount of  $\alpha$ -cellulose present is slightly above the minimum usually present in bleached sulphite pulp used for artificial silk production. Moreover the quality of the pulp as shown by its copper number, phloroglucinol absorption value, and acetone extract, is very satisfactory, these values being all very low. It will be observed that the bagasse pulp contained a rather large amount of  $\beta$ -cellulose, and in this respect resembled cotton rather than sulphite wood pulp.

This investigation shows that bagasse, on suitable treatment, is capable of producing pulp similar in chemical composition to the wood pulp employed in the manufacture of artificial silk. The behaviour of the pulp would, however, have to be determined by manufacturing trials before a definite pronouncement could be made as to its suitability for the purpose. It will be seen that soda pulp of the requisite purity, as obtained in Experiment B, was produced only after a preliminary process of mechanical and chemical treatment, in order to separate from the fibrous portion of the bagasse the large amount of useless pithy material present, which constituted approximately two-thirds of the original bagasse. This process would probably offer little difficulty in the factory, with the employment of suitable mechanical agitators by means of which an even better separation of the pithy matter might be secured, and, as a result, pulp obtained with a still higher  $\alpha$ -cellulose content than that produced in the present experiments.

The yield of dry bleached pulp obtained in Trial B from the fibre (after removal of the pithy matter), viz. 63 per cent. of the air-dry material, was very good, but it will be seen that this amount only represented about 24 per cent. of the original bagasse, whereas, on a commercial scale, spruce yields from about 45 to 50 per cent. of pulp.

## 2. TASMANIAN STRINGY-BARK PULP

This material was received from the High Commissioner for Australia and was stated to represent bleached sulphite

pulp prepared from the wood of upland-grown Tasmanian stringy-bark (*Eucalyptus obliqua*). It was forwarded from Australia by the Commonwealth Council for Scientific and Industrial Research with a view to its examination and submission to manufacturers of artificial silk as a source of cellulose for their purposes.

The material consisted of four parcels of clean, white sheets of pulp of uniform appearance,  $8 \times 8$  in. and  $\frac{1}{16}$  to  $\frac{1}{8}$  in. in thickness. The four samples were labelled as follows :—Cooks 7 and 8 ; Cooks 9 and 10 ; Cooks 11 and 12 ; Cook 13.

Two of the samples (" Cooks 7 and 8 " and " Cook 13 ") were chemically examined with the following results, which are shown in comparison with the corresponding figures recorded for bleached sulphite pulp of a quality suitable for the manufacture of artificial silk :

—	Present results.			Figures recorded for bleached sulphite pulp.
	Cooks 7 and 8.	Cook 13.	Mean.	
Moisture . . . . . per cent. Calculated on the moisture-free material:	8.9	8.5	8.7	8-12
Ash . . . . . per cent.	0.32	0.32	0.32	0.15-0.3
$\alpha$ -Cellulose . . . . . per cent.	88.7	88.6	88.6	85-89
Acetone extract. . . . . per cent.	0.49	0.39	0.44	0.6-0.7
Copper number (Braidyl) . . . .	2.04	1.75	1.9	Not over 3

These results show that the pulp was of a very satisfactory degree of purity and contained a high percentage of  $\alpha$ -cellulose. So far as chemical composition is concerned it would be quite suitable for the manufacture of artificial silk.

The pulp was submitted to two firms of artificial silk manufacturers, who reported on it as follows :

(1) One firm stated that from the results of analysis obtained at the Imperial Institute the pulp would appear to be quite suitable for use as a source of cellulose for artificial silk but that a manufacturing trial would be necessary in order to decide the question.

(2) The second firm reported that the figures indicated a good quality of wood-pulp, which would probably work quite satisfactorily in the manufacture of artificial silk by

the viscose process. They offered to carry out a works test of the pulp in order to ascertain definitely its suitability for their manufactures, if about 15 cwt. to 1 ton could be furnished for the purpose.

As indicated above, this sulphite pulp from Tasmanian stringy-bark is of suitable chemical composition from the point of view of artificial silk manufacture, but trials on a technical scale are necessary before its value for the purpose can be definitely ascertained. It was therefore suggested to the Australian authorities that if it appears likely that stringy-bark pulp of this quality could be offered in commercial quantities at a price in the neighbourhood of £23 per ton c.i.f. English port, a quantity of about 1 ton should be supplied to the firm in question for the purpose of the trial which they had offered to carry out. Information was also requested as to the quantities which could be regularly supplied if the firm were prepared to place definite orders for shipments.

### 3. PHORMIUM TENAX FIBRE

This investigation, which was carried out on a sample of New Zealand hemp of good quality, was undertaken at the request of the Department of Scientific and Industrial Research in New Zealand in connection with suggestions which had been made for the installation in New Zealand of a factory for the production of artificial silk.

The fibre was found to contain 8.5 per cent. of moisture, and 70.25 per cent. of cellulose, expressed on the moisture-free material. It was cut into pieces about 2 in. long and was then treated with caustic soda under conditions similar to those employed for the production of soda pulp on a commercial scale. The results are given in the following table :

Caustic soda used.		Conditions of digestion.		Parts of caustic soda consumed per 100 parts of fibre.	Yield of dry bleached pulp.
Parts per 100 parts of solution.	Parts per 100 parts of fibre.	Time.	Temp.		
20	3	hours. 4	° C. 140 <sup>1</sup>	11.8	Per cent. 64.5 <sup>2</sup>

<sup>1</sup> 40 lb. per sq. in. pressure.

<sup>2</sup> Equivalent to 70.5 per cent. expressed on the moisture-free fibre.

The material when treated under these conditions and subsequently bleached furnished a strong, white, silky-fibred pulp, the fibres of which could be readily separated.

On analysis the pulp gave the following figures which are compared with those recorded for bleached sulphite pulp suitable for the manufacture of artificial silk :

—	Present sample.	Figures recorded for bleached sulphite pulp of satisfactory quality.	
		(1)	(2)
Moisture . . . . .	2.9	8 to 12	10
Calculated on the dry material:			
Ash . . . . . per cent.	0.09	0.15 to 0.3	0.1 to 0.4
λ-Cellulose . . . . . per cent.	89.8	85 to 89	86 to 89
β-Cellulose . . . . . per cent.	7.0	—	6 to 8
γ-Cellulose . . . . . per cent.	3.1	—	3 to 5
Acetone extract . . . . . per cent.	0.12	0.6 to 0.7	—
Copper number . . . . .	0.824	Not over 3	2 to 3

This investigation showed that *Phormium tenax* fibre furnishes 70 per cent. of bleached pulp (calculated on the moisture-free fibre). The composition of the pulp compares very favourably with that of the bleached sulphite wood-pulp commonly used for artificial silk manufacture, the low copper number being a very satisfactory character. The analysis therefore indicates that phormium pulp should be quite suitable for the preparation of artificial silk, but a manufacturing trial would be necessary before a definite conclusion could be reached, as the physical properties of the pulp would have to be taken into account.

The feasibility of employing the pulp for the manufacture of artificial silk in New Zealand or of exporting it for the purpose would obviously depend on the price at which it could be produced. In this connection it was mentioned that the price in the United Kingdom of good quality wood-pulp imported for the manufacture of artificial silk was about £23 per ton c.i.f. (December 1928). As phormium tow was realising £19-£20 per ton in the United Kingdom and 3 tons would be required to make 2 tons of pulp, it seemed doubtful whether its employment for the manufacture of pulp would be remunerative, especially when the costs of conversion were taken into account. These would include interest and depreciation on the factory and equipment, the cost of chemicals, fuel, labour and superintendence, etc.

FRUITS AND SEEDS OF *ALEURITES*  
*FORDII* FROM KENYA COLONY

At the instance of the Imperial Institute trials have been carried out in a number of British countries with species of *Aleurites* which yield the tung oil (Chinese wood oil) of commerce. In Kenya trials have been made with *Aleurites Fordii* Hems. from Hankow and *A. montana* Wils. from Hong Kong, and the results have been more promising than those obtained in other parts of the Empire.

Seeds of *A. Fordii* were sown in August 1922 at an altitude of 5,500 ft. Germination was very poor and took place in 52 days. In May 1924 the resulting plants were from 3 to 5 ft. high and in a healthy condition. Other *A. Fordii* seeds were sown at 8,000 ft. altitude. They germinated in 84 days, the germination being poor; 12 of the seedlings were planted out, but in May 1924 only one remained, which was 9 in. high. Towards the end of 1923, more sowings took place at various altitudes from 5,000 to 8,000 ft. These gave a much improved germination. In 1926 it was reported that those planted in Nairobi in 1923 at 5,600 ft. altitude were in some cases 5 to 7 ft. high, while others were stunted, being only 18 in. high. All these trees had been attacked by an *Aspidiotus* scale, which killed a number of shoots and some entire plants before it was eradicated by treatment with Habas mixture. A few of those planted at 8,000 ft. were still alive in 1926. Within the next year two of the trees at Nairobi flowered and fruited. Samples of the fruits and seeds were forwarded to the Imperial Institute for examination in 1927, the results of which are dealt with below. The fruits were very slow in ripening, having been nearly six months on the trees all through the hot dry weather and the main part of the rains. Many of the trees had then started to grow much more vigorously than hitherto, and had developed strong shoots up to 10 ft. high. In February 1928 the trees were fruiting fairly freely. They showed, however, great differences in development, some being 10 ft. high and others only 18 in. Experiments made in the Colony, elsewhere than at Nairobi, were not successful. It is proposed

to make further trials throughout Kenya, using the locally produced seed. It is not considered possible to grow these trees extensively in the Forest Reserves as these areas do not afford the combined conditions of rainfall and temperature which are desirable, but there are many other parts of the Colony where the trees should do well. Some of these trials will be made at lower altitudes and under warmer conditions. Planting at higher altitudes has not met with success.

The *A. montana* seed from Hong Kong was sown in 1922 at Nairobi at an altitude of 5,500 ft. Germination took place in 56 days, but was very poor, only one plant surviving, which reached 18 in. in height by May 1924. Further sowings took place towards the end of 1923 at various altitudes ranging from 5,000 to 8,000 ft. The germination was again poor and only a few plants remained. In September 1926 only one plant was still alive, and though healthy in appearance the growth had been slow, it then being only 3 ft. 6 in. high. This tree flowered for the first time in February 1928.

The fruits and seeds of *A. Fordii* received from Kenya were very similar in appearance to those received from China in 1922 from which the trees yielding the present samples were grown. The average weight of a single fruit was 28 grams, of a seed 3.6 grams, and of a kernel 2.3 grams. The corresponding figures in the case of the sample from China were 27.3 grams, 3.0 grams and 2.2 grams respectively.

The seeds were composed of shell 37.9 per cent. and kernel 62.1 per cent., as compared with 41 per cent. and 59 per cent. respectively in the case of the parent seeds from China.

The kernels contained 4.9 per cent. of moisture, and on extraction with light petroleum furnished 60.4 per cent. of oil, corresponding to a yield of 63.5 per cent. from the moisture-free kernels. The kernels of the original China seeds yielded 59.0 per cent. of oil, expressed on the moisture-free material.

The oil was pale yellow, rather viscous, and had a slight, characteristic odour. On examination it furnished the following constants, which are compared with those

given by the oil derived from the seeds from China referred to above, and by a sample of oil received from China.

	Present sample.	Oil obtained from seeds from China.	Oil received from China.
Specific gravity at 15/15° C.	0.9433	0.9405	0.9414
Acid value . . . . .	0.52	0.63	0.43
Saponification value . . . . .	192.7	193.5	195.3
Iodine value (Hübl, 17 hrs.) . . . . .	172.8	174.8	172.0
Unsataponifiable matter			
per cent.	0.4	0.3	0.4
Refractive index at 40° C. . . . .	1.512	1.513	1.513

These results agree closely with those obtained for the oil prepared at the Imperial Institute from the original Chinese seeds and for the oil prepared in China. Such oil would be saleable in the United Kingdom at a price similar to that of wood oil from Hankow which was quoted at 83s. per cwt. in London, spot, barrels (August 1927).

It is evident, therefore, that the seeds produced in Kenya from seeds of Chinese origin closely resemble the latter and give a similar or slightly higher yield of oil of the same character.

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## FRUITS AND SEEDS OF *HYDNOCARPUS* *WOODII* FROM NORTH BORNEO

CONSIDERABLE attention has been devoted in recent years to the study of chaulmoogra oil, used in the treatment of leprosy, and to the possibility of growing the plants which yield this oil in various British countries other than India, their native home. The principal plants concerned are species of *Hydnocarpus* and *Taraktogenos Kurzii*. Particulars of experiments carried out with these plants in Malaya will be found in *Kew Bulletin* No. 2, 1927, pp. 49-56, whilst an account of trials in Ceylon is given in *Tropical Agriculturist* (1928, **71**, 199); an abstract of the latter will be found on page 107 of this BULLETIN. For general information on the subject of chaulmoogra oils the following publications may be consulted: "The Treatment of Leprosy by Vegetable Oils," by Dr. T. A. Henry, with notes on the species yielding chaulmoogra oil (*Kew Bulletin* No. 1, 1926, pp. 17-23); "Les Huiles de

Chaulmoogra," by René Jumelle (Orléans: Imprimerie Henri Tessier, 1926); "Chaulmoogra et autres Graines utilisables contre la Lèpre," by Ém. Perrot (*Notice No. 24, April 1926, Travaux de l'Office National des Matières premières végétales, Paris*); "A Comparative Analytical Study of Various Oils in the Chaulmoogra Group," by G. A. Perkins and A. O. Cruz (*Philippine Journal of Science*, 1923, **23**, 543-569); "The Chaulmoogra Tree and Some Related Species," by J. F. Rock, F. Fairchild and F. B. Power (*Bulletin No. 1057, United States Department of Agriculture*, 1922).

In May 1925 fruits and seeds of the species, *Hydnocarpus Woodii*, were sent to the Imperial Institute by the Conservator of Forests, North Borneo, in order to ascertain whether the oil in the seeds is likely to possess therapeutic properties similar to those of Indian chaulmoogra oil. Many trees of this species are found growing near Sandakan and if the oil proved to be of value it was proposed to reserve the existing trees and plant others.

The fruits received at the Imperial Institute were roughly spherical in shape, about  $2\frac{1}{2}$  in. in diameter, and of brown colour. Each fruit contained seven or eight seeds about 1 in. long, embedded in pulp. The seeds, which were in a very moist condition, had a brown, thin, brittle, woody shell enclosing a kernel covered with a brown seed-coat; the cotyledons were foliaceous. The seeds had an average weight of 3.2 grams and consisted of shell 39 per cent. and kernel 61 per cent.

The kernels, after being air-dried, contained 7.8 per cent. of moisture and on extraction with light petroleum yielded 57.4 per cent. of oil, corresponding to a yield of 62.3 per cent. from the moisture-free kernels. The oil thus obtained was a hard cream-coloured solid, with a strong cheese-like odour. On examination it furnished constants which are shown in table on p. 14 in comparison with those previously recorded for the oil of *Hydnocarpus Woodii* seeds.

In order that the characters of the oil could be more completely investigated, a further supply of seeds was obtained from North Borneo in August 1927. The seeds, which were rather larger than those examined previously,

*Hydnocarpus Woodii* Oil

	Present sample.	Figures previously recorded. <sup>1</sup>
Specific gravity at 100/15° C.. . . . .	0.8989	—
Acid value . . . . .	32.8	11.7
Saponification value . . . . .	202.4	192
Iodine value (Hübl, 17 hrs.) . . . . .	85.8	68.5 <sup>2</sup>
Unsaponifiable matter . . . . .	0.5	—
Refractive index at 40° C. . . . .	1.471	1.469
Melting point, °C. . . . .	28.5	—
Optical rotation of oil in chloroform (α) D 20° . . . . .	+53.1°	+45.9° <sup>3</sup>
Solidifying point of fatty acids, °C.. . . .	44.6	43
Optical rotation of fatty acids in chloroform (α) D 20° . . . . .	+54.4°	+53° <sup>3</sup>

<sup>1</sup> *Philippine Journal of Science*, 1923, **23**, 543 (results obtained with seed from North Borneo).

<sup>2</sup> By the Hanus method.

<sup>3</sup> At 30° C.

were mostly wedge-shaped, with one curved side and two or three flat sides, and were from 1 to 1½ in. in length, but a few were spherical and some semi-spherical, with a diameter of 1 to 1½ in. The seeds consisted of shell 54 per cent. and kernel 46 per cent. The shells were thin, brown, brittle and woody. The kernels were brown externally and yellowish-white to brown internally, but many kernels were shrivelled or mouldy. The average weight of the seeds was 4.2 grams and of the kernels 2.1 grams. These figures differ from those found for the seeds received in 1925, the seeds being heavier and the proportion of shell much higher; in the earlier sample, the shells formed only 39 per cent. of the seeds.

The kernels contained 8.1 per cent. of moisture and, on extraction with light petroleum, yielded 55.4 per cent. of oil, corresponding to a yield of 60.3 per cent. from the moisture-free kernels, as compared with 62.3 per cent. in the case of the previous sample. The oil was a fairly hard, dark cream-coloured solid, with a strong rancid odour. It was examined with the following results, which are shown in comparison with the corresponding figures recorded for (a) the previous sample examined at the Imperial Institute and (b) a sample of North Borneo seed examined in the Philippine Islands :

	Present sample.	Comparative figures. (a) (b) <sup>1</sup>	
Optical rotation of oil in chloroform (α) D 20° . . . . .	+48.9°	+53.1°	+45.9° <sup>2</sup>
Optical rotation of fatty acids in chloroform (α) D 20° . . . . .	+49.8°	+54.4°	+53° <sup>2</sup>

<sup>1</sup> *Philippine Journal of Science*, 1923, **23**, 543.

<sup>2</sup> At 30° C.

In order to study the constituents of the oil, the following method was adopted, based on the fact that the ethyl ester of chaulmoogric acid has a higher boiling point than the ester of hydnocarpic acid.

The ethyl esters of the fatty acids were prepared from the oil according to the method adopted by Perkins and Cruz (*Philippine Journal of Science*, 1923, **23**, 557). The mixed esters were then distilled under reduced pressure, and the higher and lower boiling fractions separated and used respectively for the detection of chaulmoogric acid and hydnocarpic acid.

For the latter purpose the two fractions were saponified and the free acids obtained. These were recrystallised once from alcohol, dried, and recrystallised from light petroleum after filtration. The recrystallisation from light petroleum removed a small amount of resinous material which is insoluble in this solvent. After repeated recrystallisations the chaulmoogric and hydnocarpic acids were isolated from their respective fractions as lustrous crystalline solids.

The two acids were thus obtained in sufficient quantity to permit of their identification and characterisation, the results obtained being shown in the following table in comparison with the figures previously recorded :

—	Chaulmoogric acid.		Hydnocarpic acid.	
	Present results.	Figures previously recorded.	Present results.	Figures previously recorded.
Melting point, °C. . . .	67–68	68 (a)	58–59	59–60 (c) 60 (d)
Specific rotation . . . .	+61.9°	+56° (a) +60° (b)	+68.2°	+68.1° (c) +70.7° (d)
Iodine value (Hübl, 17 hrs.) per cent.	89.3	90.6 (e) 90.1 (a)	99.5	100.7 (e) 100.2 (c)
Percentage of silver in silver salt . . . . .	27.2	27.9 (e)	29.8	30.1 (e)

(a) Power and Gornall (*Journal of the Chemical Society*, 1904, **85**, T. 838).

(b) Goulding and Akers (*Proceedings of the Chemical Society*, 1913, **29**, 197).

(c) Power and Barrowcliff (*Journal of the Chemical Society*, 1905, **87**, T. 884).

(d) Perkins, Cruz and Reyes (*Journal of Industrial and Engineering Chemistry*, 1927, **19**, 939).

(e) Calculated from the theoretical molecular weight.

The present investigation has demonstrated the presence in the oil of *Hydnocarpus Woodii* seeds of the glycerides of both hydnocarpic and chaumoogric acids. In this respect the oil agrees with that from the seeds of *Hydnocarpus Wightiana*, which is widely employed in the treatment of leprosy.

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## CAUSES OF VARIATION IN PLASTICITY OF PLANTATION RUBBER

THE following is a report of the London Committee of the Ceylon Rubber Research Scheme on the results of investigations carried out at the Imperial Institute.

### INTRODUCTION

In view of the demand for rubber of uniform plasticity, the question of the extent and causes of the variation in the plasticity of plantation rubber is receiving considerable attention both in Java and Ceylon. In tests carried out at the Imperial Institute marked differences were found in the plasticity of samples from a number of Ceylon estates and a detailed study of the causes of this variation has been commenced.

Specimens of rubber for use in these investigations were specially prepared in Ceylon by Mr. O'Brien and six months later were tested at the Imperial Institute by the London staff of the Scheme by the methods described in this BULLETIN (1927, 25, 229).

The samples consisted of crepe prepared by (1) keeping the coagulum in the serum for different periods before rolling ; (2) passing the coagulum through the rollers for different numbers of times ; (3) adding different amounts of sodium bisulphite to the latex ; (4) coagulating latex of different dilutions ; and (5) passing dry crepe through different types of rolls to convert it into blanket crepe.

Before dealing in detail with the individual experiments conducted at the Imperial Institute, a short summary of the results obtained may be found useful. They indicate that some of the methods of preparation employed

have a marked effect on the plasticity of the rubber as shown below :—

Treatment.	Effect on plasticity.
Keeping coagulum in serum (maturation)	Marked decrease.
Passing coagulum through rollers for different numbers of times	Marked increase when coagulum is rolled excessively.
Addition of sodium bisulphite to latex	Marked decrease.
Coagulating latex of different dilutions	Little effect.
Passing dry crepe through different types of blanketing rolls	No definite conclusion.

The period during which the coagulum is kept in the serum before rolling and the amount of bisulphite added to the latex appear to be two causes which may effect the plasticity of commercial grades of rubber. These conclusions are provisional and require confirmation, but it is evident that it will be necessary to pay considerable attention to both these points in future investigations.

It has also been shown incidentally in the course of these experiments that drying crepe in hot air causes a considerable increase in plasticity. This is of importance in connection with the preparation of blanket crepe and also suggests a reason why smoked sheet is usually more plastic than air-dried sheet. These questions are still under investigation.

## RESULTS OF EXPERIMENTS

(1) *Keeping coagulum in serum for various periods before rolling.*—In previous tests on various samples of rubber from different estates in Ceylon (see this BULLETIN, 1927, 25, 218), it was observed that the most plastic samples generally vulcanised slowly and the least plastic samples quickly. As the time required to vulcanise a sample of rubber is considerably reduced when the wet coagulum is kept for some time before machining, it was decided to determine in the first place the effect on plasticity of keeping the coagulum in the serum for various periods.

At the request of the London Advisory Committee of the Scheme, sets of samples were prepared on two different estates in Ceylon for investigation. In both cases the latex was treated with sufficient acetic acid to cause complete coagulation in three hours, and portions

of the coagulum were removed from the serum and rolled to thin crepe at various intervals after the addition of the coagulant (*viz.*, 3, 6, 19, 21, 24, 27, 30 and 42 hours in the first experiment and 3, 6, 18, 21, 24, 27, 30 and 45 hours in the second experiment). These periods are not sufficiently long to affect the time of vulcanisation markedly, but they more than cover the variation in procedure on different estates, and the results should indicate whether the practice of machining the coagulum on the day of coagulation yields rubber of the same plasticity as that obtained from coagulum machined the next day.

The following are the results of plasticity tests on the raw (unmasticated) and masticated rubber:

Sample No.	Interval between coagulation and rolling.	Raw rubber.		Masticated rubber.	
		$D_{30}^1$	Time of mastication.	$D_{30}^1$	Ev. <sup>2</sup>
(r)	(hrs.)	(mm./100)	(mins.)	(mm./100)	(ccs.)
A. 1319	3	157	23	74	12.4
1320	6	159	21	75	12.8
1321	19	163	21	77	10.0
1322	21	161	20	78	8.7
1323	24	172	21	77	9.1
1324	27	169	20	79	9.1
1325	30	173	22½	86	7.4
1326	42	169	22	84	7.9
B. 1336	3	162	17½	78	10.9
1337	6	169	17½	80	10.1
1338	18	170	18½	86	9.4
1339	21	177	17	86	8.6
1340	24	172	17	87	7.5
1341	27	178	16½	89	7.2
1342	30	175	16	91	7.8
1343	45	183	16	99	5.6

<sup>1</sup>  $D_{30}$  = Thickness (in hundredths of a millimetre) of sphere 0.4 gram in weight after pressing in parallel plate plastimeter at 100° C. for 30 minutes.

<sup>2</sup> Ev = Volume in ccs. extruded in 1 hour at 90° C.

The results in column 3 relate to the plasticity of the raw rubber before receiving mechanical treatment at the Imperial Institute and those in columns 5 and 6 to the plasticity of the masticated rubber. Owing to the use of different types of instrument a plastic rubber is indicated by a low figure in columns 3 and 5 and by a high figure in column 6.

In both sets of samples the most plastic specimens are those in which the coagulum was converted into crepe after

the shortest interval. On the whole the rubber becomes harder the longer the coagulum is kept in the serum. The most plastic sample of masticated rubber is nearly 70 per cent. more plastic than the hardest in the first set and 90 per cent. in the second set.

The samples were vulcanised in a rubber-sulphur mixing (90 : 10) at 148° C. for 100 minutes in the case of the first set of samples and for 120 minutes in the case of the second set, with the following results :

Sample No.	Interval between coagulation and rolling.	Tensile strength.	Elongation.		Calculated time of vulcanisation.
			At break.	At load of 1.04 kgs./sq. mm.	
(1)	(hrs.) (2)	(lbs./sq. in.) (3)	(per cent.) (4)	(per cent.) (5)	(mins.) (6)
A. 1319	3	1,360	935	941	142
1320	6	1,700	944	916	135
1321	19	1,830	955	925	138
1322	21	1,700	937	905	133
1323	24	1,390	938	926	138
1324	27	1,730	951	908	133
1325	30	1,940	957	900	131
1326	42	1,770	937	903	132
B. 1336	3	1,730	900	859	141
1337	6	1,810	920	809	129
1338	18	2,040	891	830	134
1339	21	2,170	929	852	139
1340	24	2,310	919	833	135
1341	27	2,180	922	843	137
1342	30	2,150	924	845	138
1343	45	2,040	885	825	132

When allowance is made for the degree of cure the tensile strengths of the samples are satisfactory.

In both sets, keeping the coagulum in the serum for various periods up to 45 hours has not resulted in an appreciable alteration in the time of vulcanisation. Longer periods of " maturing " are known to have a marked effect on time of vulcanisation and it is proposed to study their effect on plasticity.

(2) *Number of rollings of coagulum.*—When dry rubber is repeatedly passed between rollers in manufacturing operations its plasticity quickly increases, but no information is available as to the effect on the plasticity of the dry rubber of rolling the wet coagulum and it was decided that the question should be investigated.

For this purpose samples of thin crepe were prepared

in Ceylon from the same coagulum by passing portions 2, 5, 10, 20 and 40 times between grooved rollers and once between smooth rollers, the experiment being repeated 6 weeks later. The coagulum was obtained by the addition of 1 part of acetic acid to 200 parts rubber, using 20 per cent. latex to which had been added 1 part sodium bisulphite to 200 parts rubber.

The following are the results of plasticity tests :

Sample No.	Number of times passed through grooved rollers.	Raw rubber.		Masticated rubber.	
		D <sub>20</sub> .	Time of mastication.	D <sub>20</sub> .	Ev.
(1)	(2)	(mm./100)	(mins.)	(mm./100)	(ccs.)
A. 1344	2	181	21	83	8.6
1345	5	175	21	82	11.3
1346	10	174	22	78	10.9
1347	20	161	22	77	11.0
1348	40	149	22	69	16.7
B. 1373	2	175	19½	80	9.2
1374	5	176	20	79	6.7
1375	10	185	19½	85	9.2
1376	20	177	20	87	9.3
1377	40	152	21	80	12.8

The results given by tests on the raw (unmasticated) rubber (column 3) and on the masticated rubber (columns 5 and 6) show that the amount of rolling the coagulum receives has no definite effect on plasticity until the coagulum has been passed through the rollers more than twenty times.

There is no indication from these experiments that variations in the number of rollings, such as are likely to occur on estates, have an appreciable effect on plasticity.

The samples were vulcanised in a rubber-sulphur mixing (90 : 10) for 120 minutes at 148° C. and submitted to mechanical tests with the results shown in table on p. 21.

Rolling the coagulum 40 times has caused the rubber to vulcanise more slowly than rolling 20 times or less. Allowing for differences in time of vulcanisation rolling the coagulum 40 times has had no appreciable effect on tensile strength in the case of the first set of samples, but appears to have caused a deterioration in the case of the second set.

Sample No.	Number of times passed through grooved rollers.	Tensile strength.	Elongation.		Calculated time of vulcanisation.
			At break.	At load of 1.04 kgs./sq. mm.	
(1)	(2)	(lbs./sq. in.) (3)	(per cent.) (4)	(per cent.) (5)	(mins.) (6)
A. 1344	2	2,120	939	860	141
1345	5	2,000	940	880	146
1346	10	2,090	960	895	150
1347	20	2,000	957	895	150
1348	40	1,630	950	935	160
B. 1373	2	2,130	901	836	135
1374	5	1,950	900	832	134
1375	10	1,970	892	829	134
1376	20	1,990	892	837	136
1377	40	1,420	877	875	145

(3) *Addition of different amounts of sodium bisulphite to the latex.*—In response to an enquiry from an estate, Mr. O'Brien prepared a series of samples to determine the minimum amount of sodium bisulphite required to maintain the colour of crepe rubber. These samples were forwarded to the Imperial Institute so that the effect on plasticity of different amounts of bisulphite might be studied.

The samples were prepared from 20 per cent. latex to which were added different amounts of bisulphite, followed two minutes later by the usual amount of acetic acid (1 : 200 dry rubber). The coagulum was rolled to crepe the next morning and after air-drying was blanketed by rolling three times through water-cooled rollers.

Particulars of the samples and the results of plasticity tests are given in the following table :

Sample No.	Proportion bisulphite: dry rubber.	Raw rubber.		Masticated rubber.	
		D <sub>25</sub> .	Time of mastication.	D <sub>25</sub> .	(Ev.)
(1)	(2)	(mm./100) (3)	(mins.) (4)	(mm./100.) (5)	(cos.) (6)
1349	nil	152	22	78	13.0
1350	1 : 533	158	21½	78	13.0
1351	1 : 400	151	21	78	12.8
1352	1 : 320	160	21	75	12.3
1353	1 : 250	160	20½	78	10.4
1354	1 : 200	167	20	82	10.2

The results in column 3 which were obtained from tests on the raw rubber indicate that there is a decided tendency for the rubber to become less plastic with increasing

amounts of bisulphite in the latex. A similar conclusion is also drawn from the results in columns 5 and 6 which were obtained from tests on the masticated rubber.

The maximum quantity of bisulphite used in the preparation of these samples is that officially recommended. Mr. O'Brien states: "It is known that the amount of bisulphite required varies on different estates, and Superintendents are always advised to make their own tests." The addition of bisulphite to latex appears to have an appreciable effect on plasticity, and as it is possible that larger amounts than those employed in these tests are sometimes used on estates, it is proposed that further experiments should be made using proportions of bisulphite in excess of the maximum quantity recommended.

The following are the results of vulcanisation tests, the samples being vulcanised in a rubber-sulphur mixing (90 : 10) for 120 minutes at 148° C.:

Sample No.	Proportion bisulphite : dry rubber.	Tensile strength.	Elongation.		Calculated time of vulcanisation.
			At break.	At load of 1.04 kgs./sq. mm.	
(1)	(2)	(lbs./sq. in.) (3)	(Per cent.) (4)	(Per cent.) (5)	(mins.) (6)
1349	nil	1,810	901	846	138
1350	1 : 533	2,100	938	859	141
1351	1 : 400	2,150	923	848	138
1352	1 : 320	1,960	938	840	136
1353	1 : 250	2,010	928	861	142
1354	1 : 400	2,200	925	850	139

As in previous experiments bisulphite has had no effect on time of vulcanisation. Dr. de Vries, however, found that bisulphite caused a slight decrease in time of vulcanisation and a small increase in strength (*Estate Rubber*, p. 94). The above results also suggest that bisulphite may have caused a small increase in strength.

Mr. O'Brien asked for observations on the colour of the samples. All the samples are equally pale, except that containing no bisulphite and the one containing the minimum amount of bisulphite. This is in agreement with the conclusion reached by Mr. O'Brien when examining the freshly prepared rubber.

(4) *Dilution of latex*.—A useful method of studying

the effect on plasticity of different amounts of serum substances is by preparing rubber from latex of different dilutions. The more dilute the latex, other conditions being the same, the smaller is the amount of serum substances retained in the dry rubber.

Samples of crepe were accordingly prepared from latex containing from 34.2 to 5.2 per cent. rubber. No bisulphite was used in the preparation of these samples and the amount of acetic acid was adjusted to the dilution of the latex.

The sample prepared from latex containing 5.2 per cent. rubber was divided into two portions, one being passed five times as usual and the other thirty-five times through the grooved rollers.

The following are the results of plasticity tests :

Sample No.	Particulars of samples.			Plasticity.			
	Concentration of latex.	Grams of rubber coagulated by 1 c.c. acetic acid.	Times passed through grooved rollers.	Raw rubber.		Masticated rubber.	
				D <sub>30</sub> .	Time of mastication.	D <sub>30</sub> .	Ev.
(1)	(2)	(3)	(4)	(mm./100)	(mins.)	(mm./100)	(ccs.)
1355	34.2	225	5	167	23	73	11.6
1356	30.5	225	5	165	21	75	10.5
1357	20.2	200	5	160	22½	74	13.1
1358	10.5	180	5	159	22	73	11.9
1359	5.2	150	5	156	23	74	13.0
1360	5.2	150	35	123	24	62	20.8

The results in column 5 indicate that there is a small increase in the plasticity of crepe from very dilute latex as compared with that from concentrated latex. Excessive machining of the coagulum (sample 1360) has, however, a much more marked effect, which is in agreement with the results given in section 2 of this report.

There is little difference in the plasticities of the masticated rubbers (columns 7 and 8) except in the case of the excessively machined sample which is much more plastic than the others.

It is concluded from this experiment that the dilution of the latex is not of great importance in connection with plasticity. As excessive machining of the coagulum causes a much more marked increase in plasticity than

excessive dilution of the latex it is unlikely that the effect of excessive machining is due to the removal of serum substances.

The following are the results of tests on samples vulcanised for 120 minutes at 148° C. in the rubber-sulphur mixing (90 : 10) :

Sample No.	Concentration of latex.	Grams of rubber coagulated by 1 c.c. acetic acid.	Times passed through grooved rollers.	Tensile strength.	Elongation.		Calculated time of vulcanisation.
					At break.	At load of 1.04 kgs./sq. mm.	
(1)	(2)	(3)	(4)	(lbs./sq. in.)	(Per cent.)	(Per cent.)	(mins.)
1355	34	225	5	2,150	888	801	127
1356	30	225	5	2,280	897	811	120
1357	20	200	5	2,030	917	848	138
1358	10	180	5	1,940	921	854	140
1359	5	150	5	1,900	927	865	145
1360	5	150	35	1,700	935	895	150

Dilution of the latex has had an appreciable effect on the rate of vulcanisation. The same effect has been noticed by other investigators, but was not observed in experiments with sheet at the Imperial Institute under the previous scheme. Allowing for differences in time of vulcanisation dilution of the latex does not appear to have had a marked effect on the tensile strength of the samples.

(5) *Effect of different types of blanketing rolls.*—In previous tests on various samples of air-dried blanket crepe from Ceylon it was shown that the most plastic sample was twice as plastic as the least. Mr. O'Brien suggested that it was desirable to determine whether this variation was due to the use of different methods of rolling "as the procedure adopted in blanketing crepe varies considerably in different factories. For example, in certain factories water-cooled rolls are used so that the temperature of the rubber is kept low. On other estates uncooled rolls are used, but are allowed to cool down after half an hour's work. Again, on other estates there is no interval for cooling and the rubber temperature may rise to 50–55° C. The number of rollings may vary from three to five."

In view of these different practices Mr. O'Brien prepared a series of blanket crepe samples from one batch of

latex rolling the crepe three and six times on different types of blanketing rolls. For comparison he also prepared air-dried thin crepe, machine-dried thin crepe and machine-dried blanket crepe.

The results of plasticity tests on these samples are shown in the following table :

Particulars of samples.					Plasticity.			
Sample No.	Type of crepe.	Method of drying.	Number of rollings of dry crepe.	Method of cooling rollers.	Raw rubber.		Masticated rubber.	
					D <sub>30</sub> .	Time of mastication.	D <sub>30</sub> .	Ev.
(1)	(2)	(3)	(4)	(5)	(mm./100.)	(mins.)	(mm./100.)	(ccs.)
1364	Thin	Air	—	—	170	20	84	7.3
1365	"	Machine	—	—	162	21½	73	11.7
1366	Blanket	"	3	Water A	139	20	76	10.9
1367	"	Air	3	"	161	20	80	8.0
1368	"	"	6	"	165	22	77	8.8
1369	"	"	3	Air B	153	21	78	8.8
1370	"	"	6	"	148	20	80	10.6
1371	"	"	3	Air C	166	20½	81	6.9
1372	"	"	6	"	145	20½	74	10.5

The air-dried thin crepe (No. 1364) is the least plastic of the series, particularly before mastication. This result is not unexpected as blanket crepe is prepared by rolling dry thin crepe (a process similar to mastication). Similarly the machine-dried thin crepe (No. 1365) is much harder before mastication than the machine-dried blanket crepe (No. 1366), but after mastication the difference between them is not very great.

The two most plastic masticated samples are those which were machine-dried (Nos. 1365 and 1366), but two of the air-dried samples (Nos. 1370 and 1372), which were rolled six times, are nearly as plastic. The latter samples were rolled between air-cooled rolls which became somewhat hotter than the water-cooled rolls through which sample 1368 was rolled six times.

It is concluded from these tests that drying in hot air considerably increases the plasticity of crepe. This confirms previous experience with machine-dried and air-dried crepe. It also appears that rolling for blanketing purposes may cause a considerable increase in plasticity, particularly if the rolls are not water-cooled. Some of the results are irregular and require confirmation.

The following are the results of mechanical tests in a rubber-sulphur mixing (90 : 10) after vulcanisation for 120 minutes at 148° C.

Sample No.	Type of crepe.	Method of drying.	Number of rollings of dry crepe.	Method of cooling rolls.	Tensile strength.	Elongation at load of 1.04 kgs./sq. mm.	Calculated time of vulcanisation.
(1)	(2)	(3)	(4)	(5)	(lbs./sq. in.)	(Per cent.)	(mins.)
1364	Thin	Air	—	—	2,280	823	132
1365	"	Machine	—	—	2,080	845	138
1366	Blanket	"	3	Water A	2,030	874	145
1367	"	Air	3	"	2,190	850	139
1368	"	"	6	"	2,170	848	138
1369	"	"	3	Air B	2,200	831	134
1370	"	"	6	"	2,260	843	137
1371	"	"	3	Air C	2,260	846	138
1372	"	"	6	"	2,070	870	144

The samples all have satisfactory tensile strengths. There is little difference in the times of vulcanisation ; the thin crepe dried in air vulcanises the most quickly and machine-dried blanket crepe the most slowly.

### CONCLUSIONS

The results of experiments described in this report indicate that six months after preparation :

(1) Crepe rubber prepared by machining the coagulum 3 hours after coagulation is about 80 per cent. more plastic than when prepared by machining the coagulum 40 hours later.

(2) Crepe rubber is nearly twice as plastic when prepared from coagulum machined more than 20 times instead of the usual number of times.

(3) Crepe rubber is about 50 per cent. more plastic when prepared from latex containing no bisulphite instead of the amount officially recommended.

(4) Crepe rubber is only slightly more plastic when prepared from very dilute latex instead of from concentrated latex or latex of normal dilution.

(5) Machine-dried crepe may be as much as 50 per cent. more plastic than air-dried crepe, and the type of rolls (whether water-cooled or air-cooled) may have an important effect on the plasticity of blanket crepe.

Dr. de Vries has shown that the plasticities of some rubbers change considerably on keeping at tropical temperatures. The above samples were kept for about four months in the London laboratories of the Scheme in addition to a short period in Ceylon and the time occupied in transit. The conditions to which the samples were subjected are therefore similar to those occurring in practice. The effects of storage at temperatures below tropical are now under investigation.

In connection with these experiments it is of importance to point out that none of the methods employed in the determination of plasticity gives results which bear a known relation to a strictly defined physical property. The methods were devised by manufacturers, and the results are stated by them to correlate closely with factory experience.

Concurrently with the above experiments a considerable amount of work has been carried out at the Imperial Institute with a view to a closer understanding of the principles involved in determination of plasticity, and the results so far obtained indicate that too much importance should not be attached to the percentage differences between the samples, as the relationship appears to vary with small differences in the conditions and methods of testing. It is unlikely, however, that the conclusions drawn in this report concerning the direction of the effect of different methods of preparation on the plasticity of crepe will be influenced by any subsequent changes in methods of testing which may be found necessary.

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#### BRICK AND TILE CLAYS FROM ISHIAGO, NIGERIA

THE three clays which are the subject of this article were sent to the Imperial Institute by the Director of Public Works, Lagos, in order that they might be submitted to technical trials to determine their suitability for making bricks and roofing tiles. It was requested that particular attention should be given to possible improvements in the methods of formation and drying already employed at the works at Ishiago with certain of the clays.

Details were given regarding the occurrence of the clays together with suggestions regarding the lines of investigation which might be followed at the Imperial Institute with a view to overcoming difficulties already encountered in using the clays for brickmaking in Nigeria.

#### RESULTS OF INVESTIGATIONS

**No. 1 CLAY.**—This consisted of a greyish-brown clay mottled with ferruginous material and containing nodules of limestone ranging in size from 3 in. in diameter downwards. This clay, which gave a good plastic mass with water, occurs in large quantity near the Ishiogo brick-works and is easy of access.

It was stated that three attempts made to work the clay had proved unsuccessful, as the limestone caused the bricks, after burning, to crack and blow badly. It was mentioned, however, that owing to the exigencies of the work the crushing rolls had to be run half an inch apart, hence fine grinding of the limestone was impossible.

With clays containing limestone it is generally considered that if "blowing" of the fired product is to be avoided, the maximum size of the calcareous particles present should not exceed  $\frac{1}{2}$  in. to  $\frac{1}{8}$  in. according to the class of ware it is desired to produce. In view of the fact that it is desired to make roofing tiles as well as bricks from the clay, it was decided to grind all the clay required for the trials described below to pass a 20-mesh sieve.

*Brick-making Trials.*—A number of test bricks were moulded from the neat clay by the stiff-plastic method, in a hand-power screw-press.

The freshly moulded bricks were set to dry in "open chequer work" at a room temperature of  $15^{\circ}$  to  $20^{\circ}$  C. No attempt to control the humidity of the atmosphere was made, but the stacked test pieces were protected from serious draughts. The formation of the pile of bricks was not disturbed until all had thoroughly dried. This procedure was adopted with all the bricks made from the clays and mixtures described in this report.

After drying, it was found that a number of the bricks showed small surface cracks, which, however, were not large enough to affect seriously the strength of the ware,

provided that no appreciable increase occurred on firing. Some warping had, however, taken place, and as this defect was more serious than the small cracks, it was thought advisable to endeavour to overcome it in the preliminary stages of the work.

The use of grog in admixture with the clay for the prevention of this warpage was next considered. A quantity of "grog" was prepared by firing some of the clay at a temperature of about  $1,000^{\circ}\text{C}$ . and grinding this material to pass a 20-mesh sieve. Two mixtures of clay and grog were prepared, one containing 10 per cent. and the other 20 per cent. of grog by weight. A number of bricks were made from these two mixtures and dried in the manner described above for the neat-clay bricks (see p. 28). It was found that the warping had been considerably reduced by the admixtures, the addition of 10 per cent. of grog appearing to be adequate for the purpose.

The three sets of test pieces were then fired together at  $1,030^{\circ}\text{C}$ . and tested, with the results given on p. 35.

*Roofing Tile Trials.*—No attempts were made to make any complicated forms of tile such as the Marseilles, only those of the flat shingle type being produced, and the word "tile" throughout this report refers to this class of tile, which was made in a steel mould by a hand-power screw-press.

A number of tiles were moulded from the neat clay by the above method, placed flat on wooden pallets in a room temperature of  $15^{\circ}$  to  $20^{\circ}\text{C}$ ., and protected from strong draughts, but no attempt was made to control the humidity. It was found that the tiles warped rather badly and showed surface cracks. In view of the fact that warpage at this stage had been practically eliminated in the brick experiments by the addition of about 10 per cent. of grog, roofing tiles were made from similar mixtures and the ware dried in a manner similar to that used for the neat-clay tiles. An examination of the test pieces showed that the addition of the grog had had beneficial results, for not only was the warpage reduced considerably, but the number of surface cracks had become negligible.

*Conclusions.*—The above tests show that fairly good bricks can be made from this clay providing reasonable

care is taken in grinding the raw material. As the limestone present in the clay occurs in fairly large lumps, it may be possible to "hand pick" the freshly quarried clay without increasing seriously the cost of production. The slight cost of this operation would in any case be more than balanced by the longer life of the grinding plant, the production of better bricks, and less waste. The addition of grog to the clay increases the porosity, but does not appear to affect seriously the crushing strength of the bricks.

It is possible to use the clay for making second-quality roofing-tiles, but it is not so well suited for this class of work as sample No. 3 (or even No. 2), as the strength of the tiles, as measured by the transverse breaking test, is somewhat low. In view of the fact that good-quality tiles can be made from sample No. 3, it is recommended that this clay (No. 1) should be used only for the manufacture of bricks.

**No. 2 CLAY.**—This sample consisted of a greyish coloured clay mottled with iron spots and enclosing a number of lumps of darker material rather harder than the bulk of the sample. It was requested that the Imperial Institute should give an opinion as to the best method for drying, by artificial heat, bricks made from this clay, as it had been found almost impossible at Ishiogo during nine months of the year to dry the bricks satisfactorily in the existing type of drying shed. Accompanying the clay were specimens of the bricks then being produced at Ishiogo from this clay.

*Brick-making Trials.*—A portion of the clay was ground to pass a  $\frac{1}{8}$  in. mesh sieve, and bricks were moulded by the stiff plastic method from this material, after which they were stacked to dry and were then fired at  $980^{\circ}$  C. An examination of the fired bricks proved that this coarsely ground clay did not lend itself to the manufacture of bricks by the stiff-plastic process; the entire brick in each case being covered with fairly large surface cracks. It is possible that the  $\frac{1}{8}$  in. material could be used with advantage in a "wire cut" brick plant, as the wetter and more plastic material required might possibly ensure a more homogeneous mixture of the clay with the harder

material present. This point, however, could not be investigated as the bulk of the available material was required for other tests.

A further quantity of clay was ground to pass a 20-mesh sieve, and a number of bricks moulded from this finer material. After moulding they were stacked and allowed to dry as previously described. It was found that the dried but unfired bricks had warped somewhat and developed a fairly large number of surface cracks. These were neither so big nor so numerous as those in the bricks made from the more coarsely ground clay, but they were nevertheless undesirable.

In view of the fact that this clay had been worked fairly successfully when mixed with clay No. 3, it was considered preferable to attempt to reduce this cracking and warping by using a mixture of these two clays, rather than to add grog for this purpose. Two mixtures were made, one containing 50 per cent. clay No. 2 with 50 per cent. of clay No. 3, and the other 33·3 per cent. clay No. 2 with 66·6 per cent. of clay No. 3 ; clay No. 3 being previously ground to pass a 20-mesh sieve. Bricks and test pieces were made from these two mixtures and dried under similar conditions to the bricks made from clay No. 1. The dried bricks, together with those made from neat clay No. 2, were fired at 980° C.

An examination of the fired bricks showed that while the cracks in the bricks made from clay No. 2 had enlarged, bricks made from mixtures of the two clays contained few, if any, surface cracks. The bricks made from the mixtures, however, still showed a tendency to warp, while in the case of those made from clay No. 2, the drying warpage had not increased. The total warpage, however, was less in the bricks made from the mixtures than in those made from the neat clay.

Further experiments showed that this tendency to warp in the kiln could be eliminated by adding a small quantity of grog to the mixed clays ; the actual proportions used were : 80 per cent. of the mixed clays to 20 per cent. of grog made from clay No. 3. The results of tests carried out on ware made from the neat clay and the two mixtures with and without grog are shown in the table on p. 35.

*Roofing Tile Trials.*—An attempt to use  $\frac{1}{8}$  in. mesh material for making roofing tiles proved unsuccessful, as they cracked badly on firing, and were somewhat weak.

When 20-mesh clay was used for this purpose it was found that although the cracks were greatly reduced in size and number, they were still sufficiently numerous to weaken the tile. Mixtures of clay No. 2 with No. 3 (with and without grog), as used for the brick experiments, were then tried with satisfactory results. The results of tests on these are to be found in the table on p. 35.

*Conclusions.*—The above results show that this clay is capable of yielding fairly good bricks by the stiff-plastic process if ground to pass a 20-mesh sieve. The use of coarser material results in the bricks having undesirable surface cracks. It is possible, however, to obtain a much stronger brick by mixing the clay with sample No. 3.

Second-grade roofing-tiles can be made from the 20-mesh neat clay, but they have a tendency to warp and are low in strength. An improvement is effected when the clay is mixed with sample No. 3, and it is advised that this be done, if the cost of production be not thereby increased to any great extent.

No. 3 SHALE.—This consisted of a yellowish-brown rather hard clay containing a fair quantity of limestone which, however, was not readily detected by the eye and hence could not be removed by hand picking. It was stated that the shale, which was taken from a 10 ft. face, is abundant; but the material has not been much used for tile-making on account of the machinery available not being suitable for the work. On account of its calcareous nature, it was found necessary for this clay to be finely ground, and material passing a 20-mesh sieve was again chosen as representing the best size for both brick and tile manufacture. The clay gave a good plastic mass with water.

*Brick-making Trials.*—A number of bricks were made by the stiff-plastic process and dried in a manner similar to that described above. It was found that the bricks had a slight tendency to warp, but in view of the fact that the mixtures of clay No. 2 with clay No. 3 had proved fairly satisfactory in this respect, it was thought unnecessary

to experiment with more than one grog mixture. Bricks were therefore moulded from a mixture of 90 per cent. of clay with 10 per cent. of grog by the method used for the neat clay, and were stacked to dry in the manner previously described. An examination of the dried ware showed that the addition of 10 per cent. of grog had greatly reduced the tendency to warp. The two sets of bricks were fired together at 980° C. and the fired products tested. The results of these tests are shown in the table on p. 35.

*Roofing Tile Trials.*—A number of tiles were made from the neat 20-mesh clay, and dried as previously described. The tiles had a slight tendency to warp on drying, but this was practically eliminated when 10 per cent. of grog was added to the clay. Results of tests on tiles made from the neat clay and from a mixture of 90 per cent. clay with 10 per cent. grog, after firing at 980° C. are shown on p. 35.

*Conclusions.*—The results of the tests show that, on account of its calcareous nature, this clay must be ground to pass a 20-mesh sieve. When this is done the clay can be made into good, strong facing-bricks by the stiff-plastic process.

First-grade tiles may also be produced from the finely-ground neat clay, and good-quality tiles can be made also by combining this sample with clay No. 2.

**BRICKS MADE IN NIGERIA.**—No. 1 brick which was sent to illustrate the "blowing" produced with clay No. 1 was somewhat rough in appearance, and contained some large calcareous lumps, one of which had caused a portion of the brick to flake off.

On breaking the brick, the appearance of the fracture rather indicated that the mixture of the raw clay with water had not been properly effected.

Apart from these defects the brick was fairly strong, and apparently sufficiently fired, but the need for finer grinding of the raw clay was obvious. The brick made from clay No. 2 was also rough in appearance, and contained a number of lumps of both calcareous and non-calcareous material, and it is obvious that much stronger bricks, more attractive in appearance, could be made by grinding the raw clay more finely.

The crushing strengths of the specimens were as follows : No. 1, 4,553 lb. and No. 2, 4,149 lb. per sq. in. These figures are inferior to those of the experimental bricks made at the Imperial Institute (see p. 35), but were, nevertheless, sufficiently high for ordinary building purposes.

#### CLAY-DRYING EXPERIMENTS

A number of experiments were carried out to determine the effect of several methods of drying on ware produced from the three clays, and the results obtained are summarised below.

*Hot-floor Dryer.*—A number of freshly moulded bricks and tiles made from the neat clays and mixtures described above, were placed in an experimental hot-floor dryer, the bricks being set in "open chequer work" in contact with the floor, while the tiles were supported about  $\frac{1}{2}$  to  $\frac{3}{4}$  in. above the floor, and stacked in 6 tiers separated by clay strips. The temperature of the floor was maintained at about 60° to 65° C.

An examination of the dried ware showed that the tiles had warped and cracked so as to be useless. The bricks had also warped, but, with the exception of the two bottom layers, had not cracked. In order to ascertain the effect of a lower drying temperature a further batch of bricks and tiles was made and kept in the dryer at a temperature of 35° to 45° C. This method largely reduced the warping of the bricks, but the tiles were still badly deformed.

The thermal efficiency of this type of dryer is very low, irrespective of whether live or exhaust steam is used, and it is generally considered unsuitable for "tender" clays (i.e. those rather deficient in plasticity and cohesive properties) on account of the irregular heating of the ware.

Results obtained from experiments carried out at the Imperial Institute indicate that this type of dryer probably would not be suitable for tiles made from the three clays under consideration. There is a possibility that it might be used for bricks made by the stiff-plastic process if the floor temperature were kept low, but the percentage of spoiled bricks might be rather high.

Results of Physical Tests on Ishiogo Clay Wares

	No. 1 neat.	No. 2 neat.	No. 3 neat.	90% No. 1 10% grog.	80% No. 1 20% grog.	50% No. 2 50% No. 3.	40% No. 2 40% No. 3 20% grog.	66.6% No. 3 33.3% No. 2.	53.3% No. 3 26.6% No. 2 20% grog.	90% No. 3 10% grog.
Water of formation <i>per cent.</i>	14.24	14.60	14.61	13.60	12.53	16.45	14.76	16.25	14.48	14.59
Maximum firing temperature °C.	1030	980	980	1030	1030	980	980	980	980	980
Duration at max. temperature <i>hours</i>	6	6	6	6	6	6	6	6	6	6
Linear drying shrinkage <i>per cent.</i>	4.80	5.20	4.13	3.95	3.25	5.10	3.25	4.95	3.05	3.35
Linear firing shrinkage " "	2.10	2.35	4.50	1.85	1.95	2.80	2.80	2.40	3.35	2.75
Total linear shrinkage " "	6.90	7.55	8.63	5.80	5.20	7.90	6.05	7.35	6.40	6.10
Transverse breaking stress unfired <i>lb. per sq. in.</i>	264	279	317	250	210	220	188	237	210	264
Transverse breaking stress fired <i>lb. per sq. in.</i>	857	943	1752	870	745	1130	971	1222	1188	1504
Porosity. " <i>per cent.</i>	27.05	29.11	21.87	23.34	23.90	26.55	27.52	26.60	27.35	26.50
Water absorption " "	13.72	15.30	10.44	14.08	14.90	13.64	13.85	13.18	13.89	13.39
Warpage (max. deflection of 6 in. tile) " <i>inches</i>	1/16	1/16	1/32	1/32	less than	1/32	nil	1/32	nil	less than
Cracking strength <i>lb. per sq. in.</i>	4972	4514	4825	4744	4300	4919	3675	5127	4159	4087
Crushing strength " "	5392	5123	5478	5484	5023	5749	5239	6037	5833	4822
Apparent specific gravity.	1.90	1.91	1.99	1.89	1.88	1.95	1.93	1.97	1.96	1.95
Weight per cubic foot of fired material " <i>lb.</i>	119	119	124	118	117	121	120	123	122	121
Colour " " "	Dark terra cotta	Light terra cotta mottled with yellow	Terra cotta	Dark terra cotta	Dark terra cotta	Terra cotta mottled with yellow	Terra cotta mottled with yellow	Terra cotta mottled with yellow	Terra cotta mottled with yellow	Terra cotta
Ring " " "	Fairly good	Poor	Very good	Poor	Poor	Good	Good	Good	Good	Very good
Fusing point of raw clay " °C	1350	1410	1375							

*Closed-chamber Dryer.*—Freshly moulded bricks and tiles were placed in an experimental drier of this type. The adjustable ventilation holes were closed and the temperature of the oven gradually increased at the rate of about  $10^{\circ}\text{C.}$  per hour up to about  $70^{\circ}\text{C.}$ , where it was maintained for about two hours. The ventilation holes were then gradually opened, and the temperature was raised to about  $100^{\circ}\text{C.}$ , at which point it was maintained for two hours.

A closed-chamber dryer could probably be used fairly successfully for ware produced from the Nigerian clays, as bricks dried under the experimental conditions were free from cracks and only slightly warped and were suitable for ordinary building purposes, while the tiles, which were not so good as the bricks, had warped somewhat but had not cracked. The total warpage of the tiles was considerably less than in the case of those dried on the hot-floor drier.

A common practice in England for drying bricks under similar circumstances is to stack them on a floor capable of being heated, cover them with wet canvas and then to cover this with tarpaulin. The tarpaulin is gradually removed after the bricks have attained the maximum temperature (about  $100^{\circ}\text{C.}$ ) and afterwards the canvas. This method gives similar conditions to the dryer described above, but has the advantage of being much cheaper. This method might be tried experimentally in Nigeria, as the expense involved would not be great, and waste heat from the kilns could be used for heating the floor.

*Humidity Type Dryer.*—A small experimental dryer of the so-called "Humidity" type was constructed somewhat on the lines of the "Tiemann" drying kiln for timber. The "green" ware is gradually heated in a current of warm air which at first is nearly saturated with moisture, but as the temperature is raised the humidity of the air current is decreased.

A quantity of freshly moulded bricks and tiles was placed in the dryer, in which a maximum humidity of about 70 per cent. was attained at a temperature of about  $80^{\circ}\text{C.}$ , after which it was gradually reduced and the temperature slowly raised to  $100^{\circ}\text{C.}$  The bricks and

tiles made from the Nigerian clays and dried under these conditions were free from cracks, and the amount of warpage was practically nil, except in the case of tiles made from clay No. 1 (neat), which had twisted to a slight extent.

It is probable that, if the cost permitted, some form of humidity dryer would be the most effective means of dealing with clays which tend to crack and become distorted when treated by ordinary methods.

Commercial dryers take many forms, a number utilising the waste heat from kilns. A very convenient plant is that of the Keller type in which a number of chambers are connected by damper-controlled flues. An exhaust fan is fitted at the far end of the dryer and draws the hot kiln gases through the drying chambers in such a way that the last chamber to be filled is also the last in circuit. Thus the chamber containing bricks that are nearly dry receives hot, dry gases, whilst the freshly charged chamber gets warm moisture-laden gases. In this respect this system acts as a form of humidity dryer, and the process is, of course, continuous. It is probable that this type of dryer would prove satisfactory for dealing with the Nigerian clays as it operates somewhat on the humidity principle, is not costly to install, and utilises waste heat.

#### GENERAL REMARKS AND RECOMMENDATIONS

It has been found possible at the Imperial Institute to make satisfactory bricks from clay No. 1, which is stated to yield bricks that crack and blow badly when worked under the conditions prevailing at Ishiogo.

It is evident from the experiments that insufficient grinding of the raw clay (due to exigencies of the work) is the chief cause of this failure, as the clay contains nodules of limestone. The plant in operation for grinding this clay in Nigeria comprises an edge runner mill and a set of rolls which have to be about  $\frac{1}{2}$  in. apart, equipment which is inadequate for dealing with calcareous clays, which need to be ground to pass a 20-mesh screen sieve. It appears evident, therefore, that a grinding plant fitted with suitable perforated grids or screens is essential.

It would be possible to reduce the quantity of lime-

stone in the clay by hand picking, but this would not obviate the necessity for the fine grinding of the remainder.

Little difficulty was experienced with clay No. 2, which is non-calcareous. Both clays Nos. 1 and 2 when used alone are more suited for making bricks than for tiles.

Shale No. 3 proved to be an excellent material for making both bricks and tiles, but it contained limestone, and fine grinding was therefore essential. Mixtures of this clay with clay No. 2 were also found suitable. It does not appear essential to submit the shale to prolonged weathering before use, but the presence of limestone necessitates fine grinding, and this procedure to a great extent takes the place of weathering or breaking down the material by natural means.

Drying the bricks and tiles does not seem to present any insuperable difficulties. When a simple hot-floor dryer is used, there is a tendency to warpage and cracking, but it should be possible to overcome this by the use of some form of closed-chamber or humidity dryer. The possible use of the waste heat from the kilns in a drying shed is well worth attention in Nigeria provided that the shed is sufficiently roomy and long to ensure slow passage of the hot air and that the heating of the goods is not too rapid.

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## ARTICLES

### TOBACCO GROWING IN SWAZILAND

SWAZILAND is situated south-east of the Transvaal, between latitudes  $25^{\circ}$  and  $28^{\circ}$  S., and is bounded on the east by Portuguese East Africa and Tongaland (part of Natal Province). The total area of the country is 4,290,661 acres (6,704 sq. miles), of which 1,638,093 acres have been set aside for the exclusive use of the Swazis. The population according to the census of 1921 was 2,203 whites, 463 coloured, and 111,106 natives (Bantu). There is a Resident Commissioner, under the High Commissioner for the Union of South Africa, and the headquarters of the Administration is at Mbabane, situated on the hills in the west of the country at an altitude of 4,000 ft.

From an agricultural standpoint Swaziland may be

divided into three main belts running north and south. To the west lies the mountainous High Veldt, of an average elevation of 4,000 ft., with an annual rainfall of 50-60 ins. The central belt, consisting of Middle Veldt, has an average altitude of 2,000 ft., and a rainfall of 30-40 ins. The eastern belt, which extends to the Ubombo Mountains, is true Low Veldt and consists largely of open bush country ; the altitude ranges from 1,200 ft. down to 700 ft., whilst the rainfall varies according to the distance from the western hills, being roughly from 15 to 30 ins. per annum.

Maize is the staple crop of the country, whilst cotton, tobacco and various native foodstuffs are also grown. Cattle ranching on a large scale has been in operation for some years. Altogether there are about 300,000 head of horned cattle, and 130,000 native sheep and goats in the territory. In addition some 350,000 merino sheep are brought in from the Transvaal High Veldt for winter feeding, but sheep of this class have so far not been farmed in the country otherwise. The territory is reported to be rich in minerals, but it has not yet been systematically prospected. Alluvial tin is being mined and shipped and a few gold mines are worked on a small scale.

The position of cotton growing in Swaziland was dealt with in an article published in this BULLETIN (1922, 20, 468).

In connection with the publication of half-yearly reports on research work conducted overseas, an interesting statement has recently been received at the Imperial Institute from Mr. E. Thomas, Tobacco Adviser to the Swaziland Government, which deals with the present position and prospects of tobacco growing in the Territory. In view of the detailed nature of this report, it has been considered desirable to print it *in extenso* in the following pages.

For the purpose of the report Mr. Thomas divides the Territory into two portions, Southern Swaziland and Northern Swaziland, the dividing line between the two being the Usutu River.

#### SOUTHERN SWAZILAND

Owing to the nature of this part of the country it is difficult to report on the three sections of High, Low and

Middle Veldts separately, and each sub-area is therefore dealt with.

*Mankaiana*.—This area can be considered under two sections, High and Middle Veldt. The prospects of the high lands of the district are good for the production of a medium tobacco saleable as a good grade of pipe and heavy grade of snuff tobaccos. The soil is of a fairly heavy texture and well adapted for these types. A leaf suitable for plug tobacco, as exported from the Union of South Africa, and which realises a good price, can be produced.

The farmers of the district are fairly prosperous, but have much to learn in connection with methods of production, cultivation, etc. They are, however, very eager to be shown methods of improving their crops, and of planting, curing, etc.

The Middle Veldt is fairly limited, consisting more of a sandy loam soil, which is capable of producing a leaf suitable for the manufacture of good cigarettes and a high grade pipe tobacco, for which, in normal times, there is a good demand. With a little encouragement this area should be one of the most prosperous of the south. It is situated near the rail-head and Union markets, and the produce can therefore be placed on the market more quickly and cheaply than that from other parts of the south. The unfortunate drawback to this district is its being situated in the hail belt, from which the farms suffer severely at times. On his first visit Mr. Thomas found 66 acres planted, carrying a crop of approximately 33,000 lb., but on again visiting the area, owing to the damage done by hail, only 25 acres were found standing, which would produce about 14,000 lb. Some farmers cut a second crop, but this cutting was of a very inferior quality owing to the injury of the plants by the hail. There are eighteen tobacco farmers in this district, and Mr. Thomas is confident that the number will increase.

*Hlatikulu district—Goedgegun*.—This district may be termed the High Veldt. It is flatter country and more exposed to the cold winds. The soil is of a fairly compact type, although there is also a quantity of sandy loam soil.

The production in this district is mostly of the heavy type of tobacco suitable for export. A small amount of

cigarette leaf is to be found, but owing to the humid climate most of the tobacco grown for cigarettes turns to a dark pipe tobacco during the process of curing in the sheds. The leading farmers are more advanced than in the Mankaiana district and anxious to improve their methods and carry out the recommendations of the Tobacco Adviser. The district would have produced an excellent exportable grade of leaf, but owing to the prevalence of "wild-fire" and insect pests, the high standard of leaf and quality was considerably lowered. It is hoped, however, that these troubles will be eradicated and Mr. Thomas looks forward to the production of a high grade tobacco and successful harvests in this district.

*Hlatikulu district—Dwaleni.*—This district is on a par with Goedgegun. At the beginning of the season the crops were looking cleaner, showing a more vigorous growth, and a heavier and good grade of leaf. Unfortunately, however, hail played havoc with the crop during the maturing stage and many farmers did not reap a leaf, and it was too late for planting a second crop. The humidity here is very great and hostile to the production of a cigarette leaf.

*Hlatikulu district—Schurwekop.*—The country below the hills produced a fair amount of suitable leaf for pipe tobacco, and with care and up-to-date methods, a good cigarette leaf can be produced. The soil is well suited for this class of crop. The farms here are situated on Low Veldt. A fairly long growing season is experienced and the region is better suited than the High Veldt to the curing of a bright leaf, which could be easily grown there. Mr. Thomas found the farmers here to be very progressive and eager to adopt improved methods and accept his advice. A portion of this area suffered from bacterial diseases caused through excessive mists and hail storms.

*Hlatikulu district—Beginsel.*—This is a good tobacco area, situated in the low country and protected by the mountains. The soil is fairly compact, but sandy soils are also found. Water for irrigation is easily obtained from the rivers. The compact soils, which are mostly situated on the western side of the Ingwavuma river, are suitable for a heavy type of leaf, but a small percentage of cigarette tobacco is also grown. On the eastern side the soil is

inclined to be a sandy loam and is suitable for the production of an excellent light red and dark leaf for the manufacture of pipe and cigarette tobaccos. Good crops were produced this season, notwithstanding that bacterial infection was found in many of the lands.

*Hlatikulu district—Mooiplaats.*—This area is similar to Beginsel as regards position, but is not such a good tobacco district. The farmers are backward, a large percentage planting their crops on dry lands, with the result that during a dry season tobacco culture becomes an expensive business, each plant having to be watered by hand. Where irrigation by gravitation is applied, the tobacco is of a fine quality and could be further improved by the use of fertilisers. A fair acreage was planted but not much reaped. The growth was poor and cutworm did a lot of damage. With the exception of three who produce a good class of tobacco, the farmers must be classed as unprogressive.

*Hlatikulu district—Onverwacht.*—The soil of the farms situated in the Low Veldt is of a very sandy loam, although compact soils are to be found. Here a good quality of cigarette leaf is grown and curing is successful owing to the climate being dry. Irrigation schemes are being installed and this section is bound to become an excellent area for high grade cigarette leaf, snuff leaf and pipe tobacco. Last season's crop was very good. Mr. Thomas found that in many instances the shed accommodation was inadequate for the crops and resulted in some loss.

*Hlatikulu district—Hluti.*—This area, which possesses both sandy loam and compact soils, should and could produce a good grade of tobacco. Water for irrigation, although scarce, has not been made full use of. The farmers know very little of the correct culture and production of tobacco and produce a medium grade of leaf. Not much attention has been given to the cultivation and the general agricultural work necessary in the production of the crops. Much must be done to get the farmers here to change their antiquated ideas for up-to-date methods of farming, but Mr. Thomas has every reason to believe this change will come about and a good marketable product be produced in this area.

*Hlatikulu district—Ingwavuma.*—This area, being low country, is fertile and, having all types of soil, can produce dark or light leaf cigarette, flue cured, and a good grade of pipe tobacco. The flats, if opened up by irrigation schemes, could produce a grade of tobacco as good as any grown in South Africa and hold its own with any district of the Union.

*Hlatikulu district—Usutu Punt area.*—This area has some of the finest tobacco farms and soils in the country. Flue curing has proved a success, and heavy and light air-cured tobaccos can also be produced in this area. A very long season is experienced. There are only three farmers here and they are very progressive. The flue-cured tobacco sent to the Union was reported upon very satisfactorily indeed. As far as could be seen it was equal to the best produced in the Transvaal last season.

*Hlatikulu district—Kubuta.*—This is another progressive area and not far below the foregoing section. Climate conditions change here a little. Light grade can be grown, owing to the many kinds of soil available, but at present the area is given up solely to the production of snuff tobacco, which is of fine quality and for which a ready market is found. The farmers are aiming for quality and are on the right road to success. Irrigation schemes have been opened up and in time this area should produce a very heavy crop of good tobacco.

*Hlatikulu district—Mtambam.*—This area has very poor soil which, however, could be improved by correct fertilisation. The grade of tobacco produced is low in quality. Irrigation schemes are very unsatisfactory, but Mr. Thomas believes that, if these were improved, the crops could be brought up to a very much higher standard. The area has two outstanding farmers who produce a very good grade of dark leaf. Leaf diseases were found to be very severe in this area owing to the soil and climatic conditions, and the ignorance of farmers with regard to methods of control.

*Hlatikulu district—Beneden and Assegai valley.*—These farms lying immediately below Hlatikulu are distinctly Low Veldt and are good tobacco farms. The seasons are long and very favourable for the crop. There are many

types of soils, both for light and heavy leaf, but the main crop is heavy leaf. With correct shedding and fertilisation a good cigarette leaf could be produced. Excepting for a little "wild-fire" the crops last season were good and found a ready market.

*Hlatikulu district—General.*—This is one of the largest agricultural districts. An area of 1,940 acres of land was planted with tobacco which, during a normal season, would have yielded a crop of approximately 1,164,000 lb. of tobacco leaf. Owing to the prevalence of hail, drought, cutworm, etc., in the latter part of this season, the actual production was 1,122,000 lb. Of this quantity, 374,000 lb. was of a good grade, containing one-tenth cigarette leaf and light pipe tobacco. With correct methods of cultivation and manuring, the cigarette leaf could be increased by 50 per cent. and the crops by 50 per cent. in value in certain areas, if the advice given to farmers by Mr. Thomas is followed out.

#### NORTHERN SWAZILAND

*Ubombo district—Stegi.*—Very little is done in this district with regard to tobacco growing, there being only about four producers of the crop. As it is situated in the High Veldt, irrigation in most parts is not possible, and consequently the tobacco is grown on dry lands. Soils are mostly of the heavy red loam and chocolate loam types. Snuff tobacco, which finds a ready sale amongst the natives, is being produced by one farmer with success. The low-lying areas contain a sandy loam soil and if irrigation is found possible a good leaf could be produced. Mr. Thomas considers that the heavier soils of Stegi are well suited for the production of fire-cured types of tobacco. The area planted in the 1927-28 season amounted to only thirty acres, but the yield proved to be very heavy, amounting to as much as 1,200 lb. per acre. Mr. Thomas considers that in places even this yield can be increased.

*Ubombo district—Signal Hill.*—This is a fine tobacco proposition, lying low and surrounded by high hills. A small acreage was planted here as an experiment. A crop good in both quality and quantity was produced. Were it not for the humidity of the climate, which would not

permit the leaf to hold the necessary colour during the curing stages, an excellent type of light leaf could be produced.

*Mbabane district—White Umbuluzi.*—The White Umbuluzi, which is low-lying country consisting mostly of a sandy loam soil, does not produce tobacco on a large scale, confining its production to meet the local demands of the natives. With irrigation this area could produce a very fine grade of leaf for cigarette and pipe tobacco. The rail-head is, however, too far distant for the farmers to reach the markets.

*Cotton Plantations.*—The soil of this farm consists mostly of a sandy loam. A small area was planted for experimental purposes, but owing to insufficient water the crop was a failure. The climatic and soil conditions are favourable to the production of a very fine cigarette leaf if water for irrigation could be obtained and the right fertiliser used. Other farms in the district are producing a very heavy pipe tobacco.

#### GENERAL

Many farms in Swaziland possess good springs which are, however, too small for the direct irrigation of a reasonable acreage of ground. By providing storage dams, the cost of which would not be beyond the means of many of the farmers, the areas under irrigation could be more than doubled. Mr. Thomas hopes to persuade and assist some of the farmers to make a start in this direction for the next season, and he is confident that when the benefit of the small outlay is fully realised, the production of tobacco will assume a more prosperous outlook.

As Mr. Thomas only took up his duties in October 1927, he was too late to advise farmers in the most important work of preparing and sowing seed beds. With regard to planting out, cutting and shedding, he was, however, able to reduce very materially the cost in respect of both time and labour. He found that in many cases the methods adopted were very crude, the growers having little or no knowledge of the production of high grade leaf. The main production in the past has been for native consumption, the tobacco being coarse and useless for export.

Mr. Thomas hopes this season to advise and instruct the farmers on the following subjects, of which the majority of them are quite ignorant: Seed-bed culture, planting, irrigation, cultivation of lands, fertilising, reaping, different methods of shedding to suit climatic conditions, conditioning, grading cellars and grading of crops, sorting, baling and collection of seed.

With very few exceptions Mr. Thomas finds the farmers most willing to accept his help and advice and readily to adapt themselves to the later and more up-to-date methods. He is confident that tobacco of every description can be produced in Swaziland equal to that of any part of South Africa, and considers that, with the Government's assistance, greater progress will be shown in tobacco production in the country, which will be for the benefit both of the farmers and of Swaziland as a whole, but owing to the great distances to be covered and the scattered farms development must necessarily be slow.

Mr. Thomas has spent much of his time in surveying the soils and climatic conditions of the various parts of the country, which contains a greater variety than any part of South Africa with which he is acquainted. The knowledge thus gained should prove of exceptional value in connection with the advisory work that is being undertaken.

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## RECENT CHANGES IN THE MINING LAWS OF THE EMPIRE

DURING the latter part of 1926, the year 1927 and the first part of 1928, there were numerous changes in the mining laws of the various parts of the Empire. Further amendments of mining and prospecting regulations were made frequently. In some cases the mining law has been entirely recast; in almost every Dominion or Colony some minor amendment has been effected.

### EAST AFRICA

The expected mining code for East Africa has not yet been enacted, but there is reason to believe that in the near future Tanganyika, Uganda and Kenya will pass a mineral code which will supersede the existing

enactments and will be substantially the same for all three countries.

#### TANGANYIKA

In the period under review there have been enacted two Ordinances: No. 10 of 1927 and No. 21 of 1928. The former, entitled the Mining Ordinance, 1927, repeals sections 27 and 36 of the Mining Ordinance, 1920, and amends section 59 of that Ordinance. The latter, entitled the Diamond Industry Protection Ordinance, 1928, regulates, restricts and safeguards dealing in diamonds.

#### NYASALAND

The mining law of Nyasaland will probably, in the near future, be reconsidered. In the period under review one Ordinance, No. 13 of 1927, has been enacted, viz. the Mining (Amendment) Ordinance, 1927, which provides for the issue of sole prospecting licences which give an exclusive right to prospect on any specified Crown lands for precious metals, precious stones, and for base metals and minerals.

#### SOUTHERN RHODESIA

In the case of Southern Rhodesia no specific change has taken place in the mining law proper, but those concerned in mining enterprise are affected by the passing of the Water Act, 1927 (Chapter I B of which contains numerous provisions relating to the use of water for mining purposes). The Licences and Stamps Act, 1927, also in a minor degree affects the charges to be borne by those engaged in mining enterprise.

#### NORTHERN RHODESIA

Four Ordinances have been passed relating to mining. These are Nos. 4 and 6 of 1927 and Nos. 3 and 6 of 1928. No. 4 of 1927 is the Mining (Forfeiture of Claims) Ordinance, 1927, and relates to abandonment and forfeiture of mining claims. No. 6 of 1927, entitled the Registration of Mining Titles Ordinance, 1927, provides for the registration of documents relating to mining titles, and supersedes the provisions of the Mining Proclamation, 1912, as regards this subject. This Ordinance is slightly amended by the

amending Ordinance No. 3 of 1928. No. 6 of 1928, being an Interpretation Ordinance, defines the term "Chief Inspector of Mines."

#### SOMALILAND

The Somaliland Mining Regulations, 1903, have been repealed and replaced by the Mining Ordinance, 1928, which provides a simple code under which prospecting and mining may proceed and by virtue of which water rights may be obtained.

#### SIERRA LEONE

In the case of Sierra Leone the law relating to mines has been entirely re-cast by the passing of the Minerals Ordinance, 1927, as now amended by the Minerals (Amendment) Ordinance, 1928 (Nos. 36 of 1927 and 17 of 1928). The Minerals Ordinance, 1927, establishes a somewhat elaborate code similar in principle to that in existence in Nigeria. The concessions system, which was previously in force, no longer controls the acquisition of mining title.

#### GOLD COAST

Four Ordinances have been passed: the Concessions (Amendment) Ordinance, 1926 (No. 22 of 1926), the Diamond Industry Protection (Amendment) Ordinance, 1926 (No. 29 of 1926), the Mining Health Areas Ordinance, 1927 (No. 11 of 1927), the Gold Mining Products Protection (Amendment) Ordinance, 1927 (No. 29 of 1927). The first-named Ordinance provides for the issue of prospecting licences under which prospecting must proceed and in minor ways amends the principal Concessions Ordinance. No. 29 of 1926 makes numerous important amendments of the Diamond Mining Industry Protection Ordinance. No. 11 of 1927 effects a minor amendment of the Mining Health Areas Ordinance. No. 29 of 1927 corrects a clerical error in section 6 of the Gold Mining Products Protection Ordinance.

#### ASHANTI

The Ashanti Concessions (Amendment) Ordinance, 1927 (No. 3 of 1927), makes an amendment to the Ashanti

Concessions Ordinance, 1903, similar to that effected in the case of the Gold Coast by the Concessions Amendment Ordinance, 1926.

### NIGERIA

The following Ordinances have been passed: the Minerals Amendment Ordinance, 1927 (No. 9 of 1927), the Explosives Amendment Ordinance, 1927 (No. 25 of 1927), the Minerals Amendment Ordinance, 1928 (No. 2 of 1928), the Survey Amendment Ordinance, 1928 (No. 10 of 1928). Of these the first-named is by far the most important, and contains numerous amendments of the Minerals Ordinance. These amendments, however, do not affect the general scheme of that Ordinance except that the mode of obtaining water rights and the extent of such rights when obtained are substantially modified. Though it is not proposed in this note to deal with the Regulations that have been made in the various parts of the Empire, the alterations effected in the Regulations by Nos. 3, 4 and 5 of 1927 are so important that a special reference should be made to them.

The Explosives Amendment Ordinance effects only an unimportant amendment of the principal Ordinance and the same observation applies in the case of the Survey Amendment Ordinance, 1928, and the Minerals Amendment Ordinance, 1928.

### SWAZILAND

The mining law of Swaziland has been materially altered by Proclamation No. 47 of 1927 as amended by No. 22 of 1928, the former being known as the Mineral Concession Areas (Swaziland) Proclamation, 1927. These proclamations confer power on the Resident Commissioner to declare any concession area open for prospecting subject to the consent of the mineral concessionaire and provide for the steps to be taken by persons desiring so to prospect such areas.

The duty is thrown upon prospectors to report discoveries; and where the High Commissioner is satisfied that there is reasonable ground for believing that precious stones or base metals exist in payable quantities on any

land open for prospecting, he may proclaim such land a public digging. By virtue of such proclamation, large rights are conferred upon the mineral concessionaire and the discoverer, and the nature of these rights and the mode of obtaining them are defined. The Mineral Rights Taxation Proclamation, 1921, is repealed and replaced by numerous provisions relating to undeveloped mineral tax, which is a tax imposed upon a concessionaire who refuses to give his consent to the throwing open of his area for prospecting. Provision is also made for the surrender of mineral concessions and the variation of the rents reserved, which rents may in certain circumstances be commuted for a royalty payment. In the assessment of such royalty the Profits Tax (Gold Mines) Proclamation, 1902, of the Transvaal as amended by the General Revenue Amendment Ordinance, 1906, is made applicable. Wide powers are conferred upon the High Commissioner for making Regulations relating to the numerous provisions indicated in the Proclamation.

#### UNION OF SOUTH AFRICA

One Act of great importance and three of minor importance have been passed. The first-named, being the Precious Stones Act, 1927 (No. 44 of 1927), consolidates and amends the laws in force in the several provinces of the Union relating to prospecting and mining for precious stones, and amends in certain respects the law relating to the diamond trade, and provides for matters incidental thereto. This Act repeals the Precious Stones Alluvial Amendment Act, 1919 (Union); so much as was unrepealed of the Precious Stones Act, 1899, of the Cape of Good Hope, and the amending Act of 1907; that portion of the Natal Mines Act, 1899, relating to precious stones; so much as was then unrepealed of the Precious Stones Ordinance, 1903, of the Transvaal, and the amending Act of 1908; so much as was then unrepealed of the Mining of Precious Stones Ordinance, 1904, and the amending Ordinances of 1906 and 1907 of the Orange Free State; and all provisions relating to precious stones contained in the Discoverers' Claims Licences Act, 1908, of the Orange Free State. The Act provides a complete code for pros-

pecting, discovery, rights of owners and surface owners of land, proclamation of mines, working of mines, alluvial diggings and the like, the maintaining of claims therein, diggers' certificates, proclamation of mines and alluvial diggings, alluvial diamond Boards and diamond dealers, together with provisions relating to water rights necessary for digging purposes, the acquisition of stands and surface rights and miscellaneous provisions relating to searching, entry, supervision of prospecting, limitation of output, issue of regulations and the like.

Act No. 2 of 1927 (the Diamond Cutting Act, 1919, Amendment Act, 1927) amends sections 1, 3 and 4 of the Diamond Cutting Act, 1919. Act 35 of 1927 (Restricted Minerals Export Act, 1927) provides for the grading of certain minerals intended for export. Certain minerals are restricted minerals and what are restricted minerals depends upon what mineral has been declared to be subject to the provisions of the Act.

Act No. 1 of 1928 (Diamond Trade Regulation (Natal) Act, 1928) relates only to Natal and empowers the Governor-General, by proclamation, to declare all or any of the provisions of the Diamond Trade Ordinance, 1903, of the Transvaal to be in force in the province of Natal subject to a special definition of the term "claim" contained in this Act.

#### SOUTH-WEST AFRICA

Apart from Proclamations relating to particular concessions two Proclamations only have been noted during the period under review. These are: Nos. 10 and 18 of 1926 (Mining Law Amendment Proclamation, 1926, and the Diamond Industry, 1926, Further Amendment Proclamation, 1926). The first-named further amends the principal law (which is Imperial Mining Ordinance for German South-West Africa as amended in 1918, 1920, 1921, 1923 and 1925). Such amendments affect sections 10, 11, 22, 23 and 26 of the principal law. No. 18 of 1926 amends the principal proclamation (being the Diamond Industry Protection Proclamation, 1922, as amended in 1924) and effects amendments of sections 10 and 11 of the principal proclamation.

## DOMINION OF CANADA

In 1927, the Dominion of Canada Acts, as a whole, were revised and are now cited according to the chapter in the Revised Statutes of 1927. Chapter 217 of the Revised Statutes, being an Act respecting quartz mining in the Yukon Territory, has been amended by the Yukon Quartz Mining Act Amendment Act, 1928, which effects a change in the royalty section (section 93).

The Petroleum and Natural Gas Regulations were also amended in 1928 by regulations made on May 7, 1928, and the regulations for leasing petroleum and natural-gas rights in school lands were issued on July 12, 1928. All the regulations relating to petroleum and natural-gas rights are contained in the consolidation printed in 1928 and issued by the Department of the Interior, Canada.

The Regulations governing the issue of leases to dredge in Manitoba, Saskatchewan, Alberta, North-West Territories and Yukon were amended by Order-in-Council of May 16, 1928, and by Order-in-Council dated March 30, 1928. These Regulations were extended to lands comprising forest reserves.

The Coal Mining Regulations were amended on February 1, 1927, by Order-in-Council empowering the Minister, where breach of regulations was believed to have occurred, to authorise a person to enter and enforce compliance with the regulations.

The Placer Mining Regulations were amended, as regards Regulations 5, 17, 19, 26 and Schedule D, by Orders-in-Council of May 29 and January 5, 1927.

The Quartz Mining Regulations were amended by Orders-in-Council of January 5, 1927 (2), and November 16, 1927. These amend Regulations 5 and 130 (2).

*British Columbia.*—The Regulations noted in the BULLETIN for 1926 were amended by Regulations issued in the *British Columbia Gazette* for December 22, 1927. The Dominion regulations that relate to the railway belt in British Columbia have already been noted under heading Dominion of Canada.

*Quebec.*—The Quebec Mining Act (R.S. 1920, c. 80) was amended in 1926 (16 Geo. V. c. 27) which act contains

amendments too numerous to particularise and by the amending acts of 1927 (17 Geo. V. c. 28) and 1928 (18 Geo. V. c. 32).

*Nova Scotia*.—1927 was a year of some legislative activity. The Coal Mines Regulations Act was amended and consolidated by c. 1 of 1927, the Metalliferous Mines and Quarries Regulation Act was amended and consolidated by c. 2 of 1927 and the Mines Act was substantially amended in very numerous particulars by c. 17 of 1927. By c. 49 of 1928 the Miners' Relief Societies Act was amended.

*New Brunswick*.—In 1927 the law relating to minerals was consolidated and amended by the Mines Act of that year and additional sections (sections 125, 126) were added by the amending Act of 1928.

*Alberta*.—Mining in Alberta is largely controlled by Dominion Regulations, the recent amendments of which are noted above for the Dominion of Canada. Safety and health regulations are, however, the subject of provincial enactments. The principal Act, the Mines Act, was amended by the Mines Act Amendment Act, 1927 (1927, c. 42).

*Manitoba*.—The same observation applies as in the case of Alberta. The Mines Act was amended by the Mines Act Amendment Act, 1927 (1927, c. 38).

*Saskatchewan*.—The same observation applies as in the case of Alberta, but no provincial amending Acts have been noted during the period under review.

*Yukon and North-West Territories*.—There is no provincial legislation and the changes applicable are noted under heading Dominion of Canada.

*Prince Edward Island*.—No legislation has been noted with regard to Prince Edward Island.

*Ontario*.—In 1927 the important Mining Act of that year, which is a consolidating Act, was passed and the other consolidating Act relating to mining, being the Mining Tax Act, 1927, became law. These two Acts are fully dealt with in Part II of Volume IV of the *Mining Laws of the British Empire and Foreign Countries* to which reference should be made. Minor amendments of the Mining Act, 1927, were effected by the Mining Act Amendment

Act, 1928 (c. 16 of 1928), sections 2, 113, 157 being the amended sections.

#### NEWFOUNDLAND

The Act of 1916, dealing with Crown lands, mines and minerals, was amended in 1927, but the amendments do not affect mining rights but timber rights. In 1927 there was also passed an Act relating to Crown royalties. In 1928, the Crown Lands Act, 1928, effected numerous amendments of the provisions of the principal Act and introduced the miners' licence system.

#### BRITISH HONDURAS

In 1927, the Minerals Ordinance, 1927, was passed. This Ordinance regulates the right to search for, mine and work the minerals, and contains provisions regarding the acquisition of rights in relation to water and restrictions with regard to the possession and purchase of minerals. The Ordinance constitutes a comparatively simple code which appears to have been modelled on the Nigerian Mining Ordinance.

#### BRITISH GUIANA

No ordinance of importance has been passed in relation to mining, though the Forest Ordinance, 1927, amends very slightly section 21 of the Mining (Consolidation) Ordinance, 1920.

In 1927 a useful index to the Mining Regulations, 1924, was published under the authority of the Governor. Consideration is now being given to certain proposed alterations in the law.

#### INDIA

In the case of the Empire of India, including Burma, no important changes have been noted.

#### PALESTINE

No changes have been made.

#### FEDERATED MALAY STATES

In addition to the numerous amendments to the Mining Rules, 1904, there is to be noted the important Mining

Enactment, 1928, which repeals and replaces the Mining Enactment, 1911, and the subsequent amending enactments of 1916, 1917, 1918, 1921 and 1927. The Labour Code Amendment Enactment, 1928, amends section 143 of the Labour Enactment, which in a slight degree affects labour in mines.

#### UNFEDERATED MALAY STATES

*Johore*.—The principal Act of 1927 was slightly amended by the Mining Enactment, 1922, Amendment Enactment, 1928 (No. 14 of 1928).

*Kedah*.—In 1927, the Mineral Ore Buyers' Enactment 1346 was passed. This replaces the various Public Dealers' and Mineral Ore Buyers' Enactment and regulates trading in minerals. In 1928 the existing mining enactments were repealed and replaced by the Mining Enactment, 1347 (5 of 1347).

*Trengganu*.—An important enactment was passed in 1927 known as the Mining Enactment 1345. This repeals I and II of 1336 (1916) and establishes a simple system of licences and lease.

*Perlis*.—No amendment for the period under review has been noted.

#### CYPRUS

A very small amendment has been effected by Nos. 3 and 32 of 1928 in the Mines Regulation Amendment Law of 1882.

#### COMMONWEALTH OF AUSTRALIA

No mining legislation has been noted relating to the Commonwealth generally. The following Acts relating to various States and the territories that are legislated for by the Government of the Commonwealth and the Federal Executive Council are noted :

*Territory of North Australia*.—The Mining Ordinance, 1927, amends section 84 and adds section 84 A to the Northern Territory Mining Act, 1903, of the State of South Australia in so far as it applies to North Australia.

*Central Australia*.—In the territory of Central Australia a similar amendment has been effected by the Mining Act, 1927, to that noted under the territory of North Australia.

*New Guinea.*—The Mining Ordinance 1922–1927 is, subject to certain reservations, repealed and replaced by the Mining Ordinance, 1928, which establishes a complete mineral code including mines regulation. The code established is similar in general outlines to those operating in the various States of Australia.

Two other important Ordinances are to be noted under date 1928, viz.: the Mineral Oil and Coal Ordinance, 1928 (No. 21 of 1928), and the Miners' Homestead Leases Ordinance, 1928 (No. 20 of 1928), both of which are incorporated in and are to be read as one with the Mining Ordinance, 1928. The former establishes a system of licences and leases under which coal and mineral oil prospecting and mining may proceed; the second makes provision for the granting of leases to any qualified person, which term is defined at some length and relates the term to any one, being a natural or artificial person, who is residing, carrying on business or other activity in a mining or coal mining field.

*Papua.*—The Mineral Oil and Coal Ordinance passed in 1926 slightly amends the Mineral Oil and Coal Ordinance, 1923–1925.

*Victoria and New South Wales.*—No legislation has been noted during the period under review.

*South Australia.*—The Mining (Prospecting for Oil) Act, 1928, establishes a system of permits to search for oil and grants preferential rights for oil leases to holders of such permits.

*Queensland.*—No. 16 of 1927, being a Mining Acts Amendment Act, 1927, amends the provisions of the Mining Act relating to permits and leases, and provides for applications for the right to construct aerial ropeways, and effects a minor alteration of the Mining on Private Land Act, 1909. The Mining Acts Amendment Act, 1927 (No. 2), assented to in January 1928, relates to the use of water for mining purposes.

*Western Australia.*—The Coal Mines Regulation Act Amendment Act, 1926, amends the Coal Mines Regulation Act, 1902.

*Tasmania.*—The Mines and Works Regulation Act, 1926, amends the Mines and Works Regulation Act, 1915.

## NEW ZEALAND

In 1927 the Coal Mines Act, 1927, was passed. This Act effects minor amendments of the Coal Mines Act, 1925. In 1926, the important consolidating and amending Act, known as the Mining Act, 1926, was passed. This has in turn been slightly amended by the Mining Amendment Act, 1927.

## GILBERT AND ELLICE ISLANDS COLONY

An ordinance known as the Mining Ordinance, 1928, has been enacted to regulate the right to mine and work minerals in the Gilbert and Ellice Islands Colony and establishes a very simple system of Crown licences followed by a Crown lease as a title under which prospecting and mining may proceed.

## BRITISH SOLOMON ISLANDS PROTECTORATE

A King's Regulation was issued in 1927 known as the Mining Regulation, 1927, which repeals the Solomons Mining Penalties Regulation, 1925, and establishes a system of miners' rights and prospecting licences together with leases for prospecting and mining. The power to grant such titles is vested in a Mining Board.

## FIJI

Nothing has been noted under Fiji, but a new Oil Mining Ordinance is in contemplation.

## NORTH BORNEO

In 1927 the Mining Ordinance, 1927, was passed establishing a general system whereby prospecting and mining proceed by virtue of permits, licences and leases.

## NOTES

**Tanganyika Agricultural and Industrial Exhibition.**—A preliminary notice has been issued relating to an Exhibition of the agricultural and industrial resources of Tanganyika, which is to be held under the Presidency of H.E. the Governor, Sir Donald Cameron, K.C.M.G., K.B.E., at Dar es Salaam in September 1929. It is intended that the Exhibition shall be representative not only of agricultural products grown by European and

native farmers, but also of the valuable cattle industry, which exceeds a capital valuation of £7,000,000. The mineral wealth of the territory, at present only just touched, will also be represented, for gold, tin, copper, coal and diamonds and other precious stones are already being commercially exploited. Forestry products are another form of wealth in which there is a vast field for development and of which exhibits will be shown.

The chief products of the country have a ready sale in the markets of the world, but the exhibition will bring to buyers information of value, not only of these main products, but of others which are showing progressive signs, such as tobacco, tea, wool and grains.

It is expected that the support of machinery manufacturers will make it possible to install in the industrial section actual working exhibits of their machinery used in the cultivation and preparation of such crops as sisal, cotton, coffee, oil seeds, tobacco, tea, and rice and other grains.

Assurance has been received that the local Government is friendly disposed towards the project and will give financial support to the exhibition. In view of the fact that this is the first exhibition of its kind to be held in the territory, there will be a number of preliminary expenses which cannot be met by entry fees alone. For this reason the Committee, of which Mr. A. H. Kirby, the Director of Agriculture, is Chairman, is appealing to merchants and trade organisations who are interested in Tanganyika for financial and other support. Appeals have already been made in Tanganyika and are being well responded to. Cheques should be made payable to "Tanganyika Exhibition Fund" and crossed Standard Bank of South Africa, Ltd. Remittances may be sent to the Standard Bank of South Africa, Ltd., 10 Clements Lane, London, E.C.4, or Dar es Salaam, Tanganyika Territory. Expenses will be kept to a minimum and most of the funds will be devoted to prizes.

It is intended that the exhibition shall be the initial step in forming an Agricultural and Industrial Society in Tanganyika, which could hold exhibitions periodically. Such an organisation would work to promote Tanganyika and British trade in co-operation with similar organisations in other parts of the Empire.

**Flax in Cyprus.**—The following account of the Cyprus flax industry has been given in the *Annual Report of the Director of Agriculture, Cyprus, for 1927*.

The year 1927 was not a good one for the flax industry,

for the Zodia factory did practically no work and the Limassol factory was destroyed by fire. However, by the end of the year things began to look better, as the Zodia factory was purchased by the Abbot of Kykko who let it to a private company, the manager of which was a well-known flax expert. The crop itself was small but the quality was good, so that shipments were made to England and good prices obtained. The question of the insurance of the flax straw is always a difficulty, but this has been solved with the help of the flax instructor, the Ionian Bank, and Mr. G. Mills of London. Mr. Mills has also assisted in obtaining credits against straw, thereby solving another problem. The factory will continue now under the management of Mr. Kacchemonaster, and Mr. Classen, the Government Expert, will give all necessary assistance.

Flax was worked by villagers in the old way and sold to Turkey, prices obtained being in the neighbourhood of £20 per ton. The price of unworked straw was raised by the Zodia factory to £7 per ton to encourage growers. Sales in the United Kingdom reached £100 per ton.

The factory at Paphos, belonging to Mr. Matsouki, continued to give its owner satisfactory results. The area which he has under flax is now 600 donums.

The lack of December rains delayed the sowing of flax, but it is anticipated that there will be a satisfactory crop.

The botanical studies on the Cyprus flax were continued experimentally. Varietal from non-variatal differences were identified (such as tillering, etc.). An article by Mr. Classen embodying the result of previous studies was published in *Near East*, June 30, 1927.

Biological studies on flax rust (*Melampsora lini*) and on the various bacteria and fungi in the retting process were continued; an article embodying part of the results was published in the "Bulletin of the Imperial Institute" (1927, 25, 320).

Technological studies of the flax shieves led to the experimental manufacture of briquettes which after ignition leave less than 2.9 per cent. of ash; retted straw leaves only 0.7 per cent. of ash. Specimens of these briquettes were submitted to the Imperial Institute for examination. The report states that: "these compare well with certain of the lower grade fuels." The calorific value has been determined to be 4,918 calories, against 3,400 for peat and 5,000 for lignite. The calorific value of coal averages 7,500 calories. "The briquette ignited readily and burnt with a large luminous flame and gave little smoke. The ash contained a fair proportion of phosphate, and hence might be useful as a manure."

Seeing that about 2,000 tons of shieves and flax straw could be obtained annually just for the trouble of collecting it, briquette manufacture might be worthy of more attention. Experiments are being continued.

A number of analyses of linseed and fibre were made. Percentage of oil in dry native linseed was found to be 45.7 per cent. (crop 1926) ; percentage of fibre in " J.W.S." straw was found to be 23, against only 15 per cent. in native straw from Paphos.

Field experiments with dew retting of straw were carried out. These are fully described in the article published in the " Bulletin of the Imperial Institute " (*loc. cit.*).

Experimental cultivation was carried out on a ten donum plot near Pyroi. The seed was " J.W.S." grown at Larnaca in 1926. It was defective, having only 82 per cent. germinating power. The soil of the plot was very heavy, and special measures had to be taken, such as frequent hoeing, to keep the crop growing. The straw produced was mostly of a very fine quality, about one metre long and sufficiently slender ; the seed was reported by the Linen Research Institute, Lambeg, to be of perfect quality. A few handfuls of straw were sent to the Institute for retting and scutching and were returned in due time. The fibre treated locally compares favourably with the specimens from Lambeg.

Cyprus linseed, no doubt owing to the insular character of the country, is certainly of a very pure strain and may almost be called a pedigree natural. Seeing its high content of oil, and the fact that climatic and geographical changes have hardly any influence on the content of oil and its chemical composition, it was thought that this seed should be saved for sowing purposes only, and not crushed for oil. Letters were exchanged with Ottawa and Delhi, and a few bushels were sent to the Institute of Plant Industry, Indore, India, for experimental growing there.

With the same object in view, namely the disposal of native linseed for sowing purposes, advice was given to the " Shemen " Company of Palestine regarding the growing of linseed for oil extraction.

A new company with apparently ample financial resources—capital £1,000,000—having been floated in Glasgow under the name of " The Pritchard Flax Fibre and Pulp Company, Limited," the possibility is given to Messaoria farmers to find a market for their flax straw which usually is abandoned on the field. Advice on this matter was given to the Trade Correspondent, Famagusta, for the Board of Overseas Trade.

In connection with this matter, a number of visits were paid to the various flax growers (for seed production only) in the Messaoria and it was found that no less than 5,000 donums would be under flax in the spring of 1928. This should produce at least 2,000 tons of straw, but owing to the lack of labour and the high cost, the harvesting of the straw cannot be tackled without the aid of special machines. Such machines are now in existence and their importation into Cyprus is under consideration.

A new irrigation scheme which involves the pumping of the Syrianochori river to the lands of Zodia will give a big impetus to the flax industry.

The following table shows the area under flax and the yield for the last five years :

Year.	Area.	Yield.	
		Flax Fibre.	Linseed.
	<i>acres.</i>	<i>tons.</i>	<i>tons.</i>
1927 . . .	882	87	216
1926 . . .	1,362	132	554
1925 . . .	1,429	266	527
1924 . . .	1,065	356	362
1923 . . .	700	278	241

**Cinchona Cultivation in India.**—A Memorandum on cinchona cultivation in India and its future development, prepared by Dr. J. M. Cowan, M.A., D.Sc., Officiating Director, Botanical Survey of India, has been published in the *Minutes of Evidence of the Royal Commission on Agriculture in India* (Vol. I, Part III, 1-12).

At present over ninety per cent. of the world's output of quinine is obtained from cinchona bark grown in Java, where there are about 40,000 acres devoted to this crop. The cultivation in Java has been scientifically controlled and over-production avoided.

The cultivation of cinchona was introduced into India in 1860 and has since been continuously controlled by the Government of India. A Government plantation was started at Dodabetta near Ootacamund in 1862, and soon after, another, also in the Nilgiris, at Naduvattam, whilst the Bengal plantations date from 1864. At about the same time private planters began to grow cinchona with such profitable results that there was an indiscriminate rush to plant, followed, between 1880 and 1890, by a flooded market and falling prices, whereupon the planters abandoned cinchona and turned their attention to tea growing, which was found to be more profitable. The fact that *Cinchona officinalis* and *C. succirubra*, the

species grown in the early plantations, yield a comparatively low percentage of quinine also contributed to the failure of private enterprise. Private cinchona growing has never revived and practically the only plantations to survive were about 4,000 acres managed by the Government.

In 1917 a survey was conducted in order to discover areas possessing the necessary conditions for cinchona growing. Special soil and climatic conditions are essential for the rapid growth of *C. Ledgeriana*, which has been grown in Bengal since 1870, as it yields a higher percentage of quinine than the varieties first introduced. Extremes of temperature must be avoided. The ideal temperature is about 75° F. with a yearly mean maximum of about 85° F. and a minimum of 60° F. The rainfall limits are roughly from 75–180 in. per annum, but the most desirable rainfall depends on the nature of the soil. In the case of a heavy soil, a high rainfall is very unfavourable, but on a well-drained, porous soil 200 in. would not be excessive. Cinchona must be planted between the altitude limits of 1,000 and 5,000 ft. and the best results are obtained on moderately steep slopes where the soil is rich, porous, well-drained and loamy. In India, such a soil, at the necessary altitude, can only be found over volcanic or granite rock formations. The accessibility of the region, the means of transport available, and the labour conditions are, of course, of fundamental importance.

When all these factors are taken into consideration the largest suitable area in South India is the Coimbatore district on the Anamalai Hills at an elevation of from 3,000 to 4,000 ft. The Government of Madras commenced planting in 1925 and some 250 acres have already been planted, mostly with a hybrid of *C. officinalis* and *C. Ledgeriana*, but in the future it is intended to grow a considerable proportion of *C. Ledgeriana*. Cinchona growing in this district, in which it is estimated that about 10,000 acres could be planted, is considered to be very promising and likely to be a financial success. Other suitable districts in South India are either too remote or already under tea.

In Burma, Tavoy was first considered the best locality and accordingly planting was started there in 1920, but as the climate was found to be unsuitable the plantation was abandoned. Growing has also been tried at Mergui, but has not yet proved a success. Mogok has been recommended as a suitable area, but it is considered that preliminary experiments would be necessary before beginning operations on a large scale.

In Assam, an area in the Mikir Hills has been stated to be one of the three most suitable localities in India. It comprises 20,000 acres of satisfactory land at an average elevation of 1,500 ft. and would probably repay exploration and experimental planting.

Undoubtedly the most suitable regions in India for the production of *C. Ledgeriana* are in the Darjeeling district of Bengal. Two Government plantations are situated there, Mungpoo with about 3,000 acres of suitable land of which 1,000 acres is bearing cinchona, and Munsong with about 2,000 acres fully stocked. It has further been proposed that an area of 4,000 acres at East Nar, in the Kalimpong sub-division, should be tried experimentally. The greater part of the suitable land in the Darjeeling district has for many years been planted with tea.

It is, therefore, concluded that the areas which offer hopeful prospects for the extension of cinchona growing are : (1) the Anamalais (10,000 acres), where work has already begun ; (2) East Nar in Bengal (4,000 acres) ; (3) the Mikir Hills in Assam (30,000 acres) and (4) Mogok in Burma (10,000 acres), making a total of 44,000 acres. The experimental planting of 50-100-acre plots in these districts is suggested. There is a fifth area, viz., the Namyin Valley in Burma which is considered worthy of exploration and experiment.

The need for research in order to increase the production of existing plantations is emphasised. Progress in this direction may be effected by improving the tree so as to increase the percentage of quinine in the bark, by shortening the rotation, and by the preparation of definite planting and harvesting schemes for the plantations. Further exploration for suitable land is also needed.

It is considered desirable that cinchona cultivation and production and the distribution of the quinine should be under the control of the Indian Government.

**The Transportation of Vegetable Oils in Bulk.**—Prior to the war, vegetable oils were shipped in barrels, drums and other containers. As a result of the shortage of available shipping during the years 1914-18, trials were made of transporting oils in bulk in steamers' deep tanks. These trials proved successful and to-day the greater proportion of the coconut oil shipped from Manila, Philippine Islands, to the United States, Japan and Europe is sent in bulk. Soy bean oil is also now shipped in tank steamers from Newchwang, China, and attempts have been successfully made recently to ship palm oil in bulk from Sumatra and

the Belgian Congo. Ground-nut oil is also shipped in bulk. Shipment in bulk possesses considerable advantages over the older method in respect of loss by leakage and time of loading and discharging. It eliminates the necessity for containers which are a costly item and may represent as much as one-third of the price of palm oil landed in Europe. Further there are no empty casks (in staves) to be returned to the country of production. On the other hand special storage tanks and other equipment are necessary at both the port of loading and the port of discharge. The deep tanks of the steamers must also be fitted with special heating apparatus when either coconut or palm oil is carried, in order to liquefy the oil prior to discharge.

In view of the importance of this method of shipping vegetable oils, it has been thought that it would be of interest to collect together recent statements on the question.

The following account of the bulk transportation of coconut oil to the United States describes the methods in use (*The Spice Mill*, 1927, 50, 781).

"Originally, coconut oil was shipped to San Francisco and other Pacific Coast cities in five-gallon cases, barrels and drums. Then a system was perfected whereby the oil was shipped in tank steamers and in deep tanks of passenger and cargo vessels operating between San Francisco and other Pacific Coast cities and the Orient. . . . Now a number of tank steamers, engaged in carrying petroleum from San Francisco to the Orient, return with a capacity cargo of coconut oil stowed away in the tanks. At San Francisco (and other cities on the Pacific Coast of the United States) the oil is pumped into steel storage tanks and later pumped into tank cars for distribution throughout the United States.

"In the Philippines and other coconut-raising countries, the coconut oil is in a liquid state, but solidifies at a temperature under 70° F., becoming a hard, dense material, resembling butter or lard. Consequently it is necessary to provide heating pipes in the tanks of the steamers, in the steel storage tanks at the docks, in tank cars used in distributing the oil throughout the United States and in the pipes extending from the docks to the storage tanks on shore. From 200 to 1,000 one-inch pipes are placed in the bottom of each tank in the steamers used. The proper placing of these heating pipes in the correct position is very necessary, because it would be very difficult, if not impossible, to liquefy the entire contents of the tanks

unless the heating pipes were properly placed. It is the practice to start heating the oil several days before the tank steamer arrives in port, so that the contents of the tanks will be liquid, permitting the discharging operations to commence as soon after docking as possible. A small head of steam is usually turned into the heating pipes at first and this pressure is gradually increased until the oil is heated to about 100° F. At this temperature the oil is in a liquid state and pumps freely.

"The oil is pumped from the tanks of the steamers very much in the same manner as petroleum oils are handled, except that special precautions are taken so that the oil will not harden in the pipes leading from the docks to the oil storage tanks on the shore. Some of the plants carry a one-inch heating tube down the centre of the delivery pipe from the storage tanks to the manifold at the dock, returning on the outside of that pipe to the boiler room of the storage plant. By turning steam into this circuit any oil that may remain in the delivery pipe can be melted out, thus eliminating the necessity of taking the pipe apart in case it should accidentally become filled or partly filled with the hardened oil. At some of the plants an air compressor is installed at the storage station, with pipes leading to the manifold at the pier. This pipe is connected to the manifold in such a manner that compressed air can be introduced into the same behind the coconut oil and all the oil forced out of the loading pipe into the storage tanks on shore. This operation is always done when the pumps are closed down for a short time, or when all the oil has been pumped from the steamer tanks, because if the oil were permitted to remain in the pipe for any length of time after pumping has stopped the oil would harden. The tank steamers engaged in carrying petroleum to the Orient and returning with coconut oil usually carry from 2,000 to 3,000 tons of the coconut oil on their return.

"A very effective system is employed to clean thoroughly the tanks of the tankers after the oil has been unloaded so that the petroleum will not affect the quality of the coconut oil and vice versa. After the petroleum cargo has been discharged at the Orient, a head of live steam is injected into the tanks. This is continued for a period of from 12 to 24 hours. After pumping out the bilges, and waiting a sufficient length of time for the interior to cool, men are sent down into the tanks to clean them as well as possible. Later upon arrival at the port where the coconut oil is to be taken on, the work of cleaning the tanks is completed. Using swabs and other equipment the men clean every part of the interior of the tanks.

When the tanks have been thoroughly cleaned, the coconut oil barges come alongside the tanker. These barges usually have a capacity of about 200 tons and are equipped with pumps, capable of pumping about 400 tons an hour. When all is ready, large hoses are run from the pump to the tank steamer's tanks. By means of these pumps and hoses the coconut oil is soon pumped from the barges to the tanks aboard the steamer. These barges ply back and forth between the coconut oil mills and the steamer until the steamer is loaded to capacity or until all the oil on hand at the mills has been exhausted.

"A number of passenger steamers plying between the Orient and San Francisco carry coconut oil in their deep tanks. The capacity of the deep tanks on the steamers of one of the lines ranges from 600 to 1,200 tons. The tanks are equipped with heating coils similar to those used on the regular tank steamers. Some of the vessels regularly engaged in the trade are equipped with permanent pumps located in the engine room, with suction piping connected direct to the vessel's deep tanks.

"On certain vessels, not equipped with pumps, a portable pumping outfit is used in discharging the oil. These pumps are placed over the deep tanks of the vessel and a certain portion of the oil is pumped out, after which they are lowered to a lower level in the tank to complete the pumping operations.

"On arrival at San Francisco these vessels usually proceed to the storage plant and discharge their oil cargo, before docking at San Francisco. In practically every instance steam is turned into the heating coils before the vessel reaches San Francisco and the oil is brought to a liquid condition, so that pumping operations may begin immediately after docking at the storage plant. After the oil has been entirely discharged the cleaning of the vessel's deep tanks is proceeded with. These tanks are arranged on some steamers so that they may be opened up and used on the return voyage to the Orient for general cargo.

"One concern operating steamers between the Orient and San Francisco carries coconut oil in one of the fuel tanks. This tank has a capacity of approximately 5,000 tons and is filled with fuel oil at San Francisco. This tank, combined with other fuel tanks, has a capacity sufficient to carry the steamer to the Orient and return. On the outbound trip the supply of oil for the furnaces is taken from the tank first. After the fuel oil carried in this tank has been used, the tank is thoroughly cleaned and made ready to carry the coconut oil on the return trip. These

passenger vessels are equipped with special pumps for delivering the oil from the tank into storage tanks, located near the docks at San Francisco. The delivery of this oil does not interfere with the loading or unloading of other cargo at the docks."

In connection with the shipment of oil in bulk three difficulties have been encountered, viz. seepage, contamination and loss in outage. These are being overcome, according to the following extract from "Trade in Philippine Copra and Coconut Oil" (*United States Department of Commerce, Trade Production Series No. 11, 1925, p. 88*).

"Seepage occurs in the shipment of bulk oil in deep tanks when the tank joints are not tight, or when rivets are loose or missing, or when escape of the liquids from the tank is possible in other ways. This loss is due to faulty construction of the tank, and its correction is directly up to the owners. In most of the vessels on the Pacific owned by the Shipping Board deep tanks have been inspected and very carefully overhauled, thus reducing the danger of seepage to a minimum. This situation is therefore improving rapidly, although up to a recent period loss due to seepage was so common that insurance companies generally would not underwrite the first 1 per cent. of such loss.

"Contamination of coconut oil occurs in two ways—the oil may be loaded into a dirty tank, with consequent discoloration, or it may be loaded into a deep tank which is adjacent to another deep tank containing fuel oil, from which seepage into the coconut oil tank occurs. The first case is due to negligence. Danger of contamination of coconut oil from this source is becoming much less as the business is being standardised into a routine. Under the method now in practice a vessel will contract for coconut oil tonnage through its agent in Manila, specifying 'deep tanks to be cleaned by the vessel.' In this case the cleaning is accomplished by alternate steaming down of the sides of the tank and wiping down with cotton waste until the walls and bottom are thoroughly clean. The tanks may also be cleaned while the vessel is in port. In this case they are cleaned by stevedores, who wash down the sides of the tank several times with a solution of soap and glycerine in water, afterwards steaming and washing the sides clean and wiping dry. When the tank is clean, the sides and bottom shine like a mirror. In either case, before loading the oil the tanks are surveyed by

two American marine surveyors, for the protection of both the vessel and the shipper. The improvement in methods of handling oil now is so great that many insurance companies will underwrite contamination risks at very low rates.

" The second source of contamination of coconut oil in deep tanks has been the proximity of other tanks containing fuel oil. This danger has been removed in most cases by orders of the owners of vessels to the effect that coconut oil and fuel oil shall not be carried in such juxtaposition.

" A third danger of contamination lies in the nature of coconut oil. This oil is liquid at temperatures above 72° F. and solid at lower temperatures. It therefore follows that the oil, which is liquid under Philippine climatic conditions, solidifies in transit to the United States or Northern Europe. This has made it necessary to equip deep tanks carrying coconut oil with steam pipes in order that on arrival at port of discharge the oil may be liquefied. In the past these steam pipes were laid in the bottom of the tank. When the steam was turned on, the coconut oil in the bottom of the tank would be liquefied. The solid oil on top would weigh down on the liquid portion, creating a pressure which, in combination with the heat, would raise the temperature of the oil far above that necessary for melting. This often resulted in a burning or discoloration of the oil, which was termed contamination, since 'contamination' in ninety-nine cases out of a hundred means nothing more than a deepening of the colour of the oil. This difficulty has been overcome in part by placing the steam coils vertically instead of horizontally in the tank. This allows the oil to rise by gravity as it melts, while the solid portion, being heavier, continually sinks to the bottom, thus establishing a current of oil in the tank from bottom to top and lessening the danger of burning.

" The use of exhaust steam is suggested instead of full-head steam. Coconut oil is liquid when loaded in deep tanks at Manila, and it is thought that it would take less steam to maintain the oil in a liquid state than it would to liquefy it after solidification. Exhaust steam could be taken off the engines and returned to the condenser after use in the deep tanks. This method would also do away with the possibility of burning the oil.

" Loss of oil in outage is often due to this characteristic of coconut oil, namely, that it is solid in temperate climates. It frequently happens that on arrival of the vessel in port of discharge the oil is not completely liquefied. Some-

times 4 or 5 in. of solidified oil remain in the bottom of the tank and must be removed by hand.

" Only one of the oil mills now operating in Manila has tank space in New York. The other mills, when selling oil on the basis of landed weights, must have the oil discharged from the vessel by stevedores. Where the vessel berths adjacent to storage tanks, the oil is pumped direct from the vessel to these tanks. In the majority of cases, however, the oil is unloaded into tank lighters by stevedores and delivered to shore tanks from these lighters. This work is generally done under contract, and it is to the advantage of the stevedores to accomplish the operation, if possible, entirely by pumping. When a considerable quantity of solidified oil remains in the bottom of the tank, or when the tank is of a certain flat-bottom construction, it is impossible to pump out all the oil, and it becomes necessary to put men down in the tank to scoop up the remaining oil by hand. This is very costly to the contractor, and he sometimes tries to have the work discharged before the tank is entirely clear.

" As it is the last 2 or 3 in. of oil in the tank that represent profit, it is of vital importance to the producer that the tank shall be discharged absolutely clear. The suggestion that the oil be maintained in a liquid state rather than be allowed to solidify, and then remelted, would ameliorate this situation. If, in addition, deep tanks for coconut oil were all equipped with conical bottoms, as some are, the necessity for the removal of the last portion of the oil by hand would be reduced to a minimum."

The bulk shipment of palm oil is at present in its infancy, but will doubtless become a regular method within the next few years. One of the principal trading firms in West Africa who ship large quantities of palm oil are of opinion that amongst the larger buyers the tendency will probably be to welcome shipments in tanks, as, when shipped in tanks leakage is, to a very great extent, eliminated and the discharge into tanks on shore facilitated. Further, this method does away with all questions of casks and their disposal. The change over will naturally be gradual, but sooner or later it is almost certain that this method of shipment will be largely adopted. On the other hand this firm considers that for a long time there is bound to be a certain demand in regular palm oil casks. There are a large number of consumers who are not large buyers and the regular palm oil cask will be required for distribution of this oil to these small consumers. Further, there is also a fairly large consuming trade throughout

Europe and elsewhere who cannot receive in tank quantities and probably they also will for a long time require delivery in the present packages.

H. M. Langton in *Chemistry and Industry* (1928, 47, 661) states :

" Successful results have followed on the attempts at bulk carriage first made by the Société Financière on the east coast of Sumatra. Oil from the estates is brought in lighters or tank wagons, pumped into large tanks at the storage wharves, and thence into the ship's tank, 600 tons of oil being loaded in this way in ten hours as against a former time of seven days, resulting in a saving of hundreds of pounds sterling in demurrage charges. In this way last year the Rotterdam Lloyd Steamship Company carried palm oil to the United States. The Elder Dempster Company have also made provision in some of their existing vessels for the carriage in bulk cargoes of palm oil from West Africa, and similar provision is to be provided in new vessels in the course of building for the same fleet.

" Bulk shipment of palm oil is also being resorted to in the Congo Belge, the oil being brought to large storage tanks by means of rail tank cars, there to await the arrival of tank steamers, into which the oil is subsequently pumped."

F. M. Dyke, of the Niger Co. Ltd., states in his *Report on the Oil Palm Industry in British West Africa* (1927, p. 14) :

" In Sumatra and in the Belgian Congo a high quality of palm oil is being produced which is being shipped from the producing country to the buyers (usually in the United States of America) in bulk. Apart altogether from convenience in handling, and economy in labour, bulk shipments have the advantage of uniformity as well as a high quality produce. It is hardly necessary to point out the disadvantage under which the native-made oil is placed in comparison with the plantation-produced oil, in that every cask of oil has its own standard of oil quality and proportion of impurity. At present, buyers are prepared to pay a small premium for the bulk deliveries of high grade plantation oil, but the latter is rapidly becoming recognised as standard and the result in the long run must inevitably be that the inferior variable native oils will permanently receive a smaller price than the standard plantation oils. This fact is so well recognised by the big trading concerns on the coast that plans are being studied for bulk handling of native-made oils. This will involve the melting out

from the cask of the native-made oil, its purification and bulking at selected centres for exporting to the various importing centres. Nevertheless, it must be recognised that these installations will cost a considerable capital expenditure in the first place and very appreciable maintenance and operation charges.

"The shipping companies will stand to benefit by the more rapid and efficient loading and discharging and the cleaner conditions during the voyage. At present, however, they show no inclination to assist and the trading concerns are having to bear the whole cost of this development. It is sufficiently obvious that this method of bulk handling of oil presupposes a suitable organisation not only at the producing centres, but also a corresponding organisation for receiving the oil in bulk in Europe or in the United States. America is far more advanced in this respect, but there are signs that continental buyers at last are awaking to the advantages of handling oils in bulk."

At the first West African Agricultural Conference held at Ibadan, Nigeria, in March 1927, A. C. Barnes, referring to the bulk transport of palm oil, said :

"There is no serious technical difficulty to be anticipated and it is probably only a matter of a year or two before all oil will be exported in bulk.

"The sedimentation of the impurities in Nigeria native extracted oil which occurred in ships' tanks during transport had introduced certain difficulties. The sludge contained a high proportion of oil necessitating special means of removing it from the sediment. With native oil it was therefore advisable to practise purification before passing the oil to the tanks and the use of the De Laval centrifugal purifiers with subsidiary washing tanks had been advocated for this purpose. By this means all dirt and practically the whole of the water was removed with but little loss of oil."

With reference to the shipment of palm oil the *Malayan Agricultural Journal* (1927, 15, 373) states :

"For bulk transport the oil would be railed in tank wagons of about five-six tons capacity, direct to the port of shipment. This method would involve the erection of large steam or electrically heated tanks with a capacity of 200 to 250 tons at the port where the oil could be stored until the arrival of the steamer.

"The tanks on the steamers will have to be fitted with heating apparatus to liquefy the oil. The temperature

of the oil will have to be raised to about 150° F. before it is discharged. This method of shipment is now being considered by a large group of estates in Sumatra from where it is understood that several trial shipments on the above lines have already been made with apparently satisfactory results."

At the Ordinary General Meeting of the Niger Company, Ltd., in February 1929, the Chairman, Mr. E. Hyslop Bell, stated, with reference to the bulk transportation of palm oil, that an experimental plant was installed in 1927 at Burutu and was subsequently enlarged, and that a second plant is now in operation at Agapa in Lagos Harbour, while a third is being commenced at Port Harcourt. Within a few months the Company will possess bulk storage plants with a capacity of about 5,000 tons, which, with the rapid rate of loading at 125 tons per hour and the comparatively short distance between the plants, will make it possible for a single tank steamer to take in a full load of palm oil in bulk within about a week. Experience has disclosed the inevitable presence of certain solids and foreign matter in native-made palm oil, which create sludge and emulsion difficulties. Special treatment plant is therefore being introduced, and in the near future the Company will be able to treat and store clean palm oils of the grades required by the market.

At some ports where there are no facilities for pumping, the oil is railed to the port of shipment in large tanks up to seven tons in capacity, which are lifted on board the steamer and emptied by gravity into the ship's tanks. This method is in use at Belewan, Sumatra.

The following notes on the transport of palm oil in bulk were read by Mr. Noel R. Redfern, M.I.Mech.E., at the Congrès National de la Navigation Intérieure held in Brussels in November 1928.

"It is perhaps needless to remind those present, more especially those gentlemen interested in the important work of developing the Belgian Congo, that the problem of transport is fundamental to success, and I trust these few notes will give you an idea how the Huileries have tackled and, it is believed, successfully solved, the special problem of transporting comparatively large quantities of palm oil in bulk, this oil being not only a more difficult and valuable product to handle in bulk in comparison with mazout, for example, but at all stages the greatest care and perfect cleanliness is essential, especially for the higher grades intended for edible purposes.

" In the earlier stages the Société naturally adopted the standard wooden palm oil cask containing about 630 kilos. as at that time this was the only recognised marketable package, but this class of package was always unsatisfactory, often involving heavy loss in transit owing to leakage, amounting to as much as 3 per cent. or 30 tons per 1,000, or even more in special cases ; skilled labour was required to make up the casks from the shooks in which they were imported and they were awkward to handle on the railway.

" Many studies were made to see if these wooden casks could not be manufactured from Congo timber, but this was found impracticable.

" It is perhaps natural that the Société should search for alternative types of containers and the steel drum was evidently the next step, but it had the serious disadvantage that the freight on the empty drums, which would normally be on a measurement basis, would make their use difficult from the cost point of view.

" To get over this difficulty, many types of steel nestable drums were examined and a bolted type was finally evolved, and although a certain number were put into use, they were not found entirely satisfactory. Moreover, there was the difficulty of recovering these special drums from the purchasers of the oil, etc.

" It is interesting to note here that in connection with a claim for infringement made against us, we unearthed a patent for a very similar drum taken out by a Belgian engineer as far back as 1886.

" With a change of transport and marketing conditions, it was later found possible to adopt the regular steel drum containing about 500 kilos. and large numbers of these, made in Belgium, were used.

" With the increasing quantities of oil to be handled, it soon became evident that not only for our own sakes but also in the general interest of Congo transport, especially on the railway, it was essential for us to adopt more advanced methods of handling our produce, and the bold policy of carrying all our oil in bulk was adopted.

" This at once involved the solution of many technical problems, as in regard to several important points there was practically no previous experience on which to work ; also it necessitated considerable capital expenditure for storage tanks, special boats, tank wagons, pipe lines and pumping plant, etc.

" It is interesting to recall that in 1912 when our revered President, the late Lord Leverhulme, visited the Congo, he proposed to use a pipe line between Leopoldville

and Matadi, and although it has not been possible to carry out his far-seeing proposals in full, we are very close to it in practice, as our oil is now handled in bulk right through from our mills on the Upper Congo to the factories in Europe and U.S.A.

" I should now like to describe in a little more detail the organisation necessary for this achievement.

" Commencing at, say, Leversville on the Kwilu River, the oil after clarification is pumped into large storage tanks containing generally 200 tons each from which it is loaded into special steamers and tank barges, all these operations being under the regular control of resident chemists.

" The steamers and barges themselves are of special interest and were designed for the purpose by our Marine Manager in the Congo, Mr. F. E. Maslen.

" The tank forms an inner skin while it has as few internal fittings as possible to allow of easy cleaning which is done by steaming and wiping down between each trip up river.

" The double skin also gives added safety in case of accident and these barges have been found very satisfactory, hardly any change having been made in their design since the first ones were built.

" It will also be noted that they are provided with permanent suction pipes connected to a manifold box for convenience in discharging at destination.

" On arrival at Leopoldville these barges are brought alongside one of the Société's two pumping pontoons which are equipped with powerful pumping plant and steam boilers and the oil is pumped over to large storage tanks according to quality, the greater proportion being of the highest grade with low free fatty acid content ; this depot being also under the regular control of a qualified resident chemist.

" The same methods of bulk palm oil transport are adopted for all the Société's mills on the main Congo River and Kasai, the only difference being that larger units are employed, and we now have barges carrying 300 tons of produce of which 200 tons is bulk palm oil.

" The next essential development was the adoption of tank wagons operating on the railway between Leopoldville and Matadi and which naturally involved a second large storage depot at the latter place to receive the oil before loading into tank steamers.

" It was at first felt very necessary to build some form of composite wagon in order to allow of these wagons being used on the upward journey for general cargo, and although

we actually drew up several plans of such wagons, none of them seemed to meet the practical requirements of the case, as far as the essential requirements of palm oil transport were concerned, and it was eventually decided to adopt tank wagons only for downward traffic without any provision for upward traffic unless possibly of a liquid nature.

" As we felt it desirable to conform as closely as possible to the Railway Company's rolling stock and at the same time meet their wishes as to the maximum possible load tare ratio, we decided upon a flat bottom tank of 20 tons nett carrying capacity mounted on a practically standard chassis for 765 mm. gauge and which in view of the high centre of gravity and the short radius curves to be negotiated appeared to us about the limit of size that would be reasonably safe.

" Forty of these wagons have now been placed in service by the Huileries, all being arranged for the eventual change to metre gauge which it is to be hoped will not be much longer delayed.

" The second lot of 20 wagons are also equipped with the vacuum brake and automatic couplings while the first lot can be converted at short notice.

" No trouble has been experienced in service except hot boxes which may be attributed largely to the operating conditions, especially in the dry season when dust is troublesome, and not to any defect in design.

" We have also experimented with a special type of axle box having a system of continuous oil circulation, and this type is reported as superior to the standard type with white metal lining.

" The regular cleaning of these tank wagons is very important and this is closely controlled, the inside of the tanks being as free as possible from any fittings, rivet heads, etc., to assist in this essential requirement.

" We are at present only getting an average of approximately two round journeys per month from each wagon, but with the improvement now being made in the line, a much better result should be obtained, and we expect at least three or possibly four trips per wagon per month ; indeed, we might hope in the not too distant future to have palm oil expresses running straight through from Leopoldville to Matadi in a day, which should allow of 6 to 8 trips per month including repairs.

" The storage depot at Matadi receives the oil from these wagons where it is pumped into storage tanks having a total present capacity of 2,100 tons.

" There is also a boiler plant with powerful pumps and

a special pipe line which allows ocean tank steamers to be loaded at the rate of 90 to 100 tons per hour, each vessel taking from 1,000 to 1,500 tons, the loading being completed in a day, so that the saving in demurrage is very considerable while there is no interference with regular steamers using the main wharves.

"Great care is observed at this point to control the perfectly clean and sound condition of the ships' tanks before loading as well as the gauging of the oil, a resident technical officer of the Société being always in charge.

"The loading is also under the control of the recognised surveyors and Customs officers, who check all operations.

"To give an idea of the good results obtained by these methods, it is found that the difference in weight is negligible, being easily less than  $\frac{1}{4}$  of 1 per cent.

"As palm oil even of the highest grade sets at a comparatively low temperature, it is necessary to make very careful arrangements in fitting out the ships to allow the oil to be pumped out in northerly latitudes, especially in winter, and on this account the ships' tanks must be very well coiled and the heating closely controlled prior to arrival at the port of discharge, otherwise much additional expense may be incurred in unloading the oil.

"As an example, in New York in winter the atmospheric temperature may fall as low as  $-23^{\circ}\text{C}$ . while the sea water at the same period varies between  $-2^{\circ}$  and  $-6^{\circ}\text{C}$ .

"Both Duplex and centrifugal pumps may be employed according to the conditions, but the details of design and materials entering into their construction must be carefully studied to enable the pumps to handle the oil without stoppages or contamination.

"Any fixed pumps or piping on the ocean steamers are to be deprecated on this latter account owing to the difficulty of adequate cleaning, as all pipe lines must be readily dismountable, in fact we have so far only employed portable pumping plants for discharging for this reason.

"The pipe line also requires to be heated, but, at the same time, special care must be taken to avoid any leakage of steam into the oil.

"The Société have also arranged the necessary shore installations in the importing countries to receive and distribute the oil to associated edible oil and soap works, etc., and it is therefore not difficult to visualise the important and careful organisation required to deal with this traffic. At the same time it is necessary to point out that it is not an economical proposition to consider bulk oil

transport of palm oil unless at least 750–800 tons per month is regularly available.

“ While we have not yet installed plant for handling palm kernels in bulk, this can be readily done, from the technical point of view, when developments justify such installations.

“ In conclusion, I trust that these few notes have given you a fair idea of these developments, and which I believe are especially interesting to the general community in view of the important economies they should effect in the transport position both on the railway and at Matadi, the transport in drums of 10,000 tons of palm oil, for example, representing the handling at the wharves and on the railway of over 20,000 drums twice over, that is to say, empty drums inwards and full drums outwards.

“ I firmly believe that the transport of palm oil in bulk, after that of copper, is leading the way to coming new methods of bulk transport for other Congo products.”

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## RECENT RESEARCH ON EMPIRE PRODUCTS

### A Record of Work conducted by Government Technical Departments Overseas

#### AGRICULTURE

##### SOILS

**Trinidad.**—The following report on the research work of the Department of Chemistry, Imperial College of Tropical Agriculture, during the six months July–December 1928, has been furnished by Professor F. Hardy.

*General Soil Work.*—Mr. Croucher reports on his own work as follows :

1. A method is being sought whereby free hydrous alumina may be estimated in soils. It is suggested that extraction of the soil with alkali tartrate solution may dissolve the free alumina, leaving the alumina combined as aluminosilicates unaffected. Preliminary experiments indicate that certain quantities of hydrous alumina are dissolved from lateritic soils by normal sodium tartrate solution.

The investigation has developed into a search for a rapid and accurate method for the determination of small quantities of alumina in presence of iron and in concentrated tartrate solution. Methods involving the decomposition of the tartrate have been rejected as being too lengthy and inaccurate. The most satisfactory method

found so far is to remove the iron as ferrous sulphide, and to precipitate the alumina from ammoniacal solution with 8-hydroxy-quinoline. The precipitate may be filtered rapidly and estimated volumetrically.

It is hoped that, by a study of these extracts, the degree of laterisation of a soil may be readily recognised, the course of laterisation traced and that some explanation of the properties of lateritic soils may be given.

2. The utility of the antimony electrode in determining pH values and its application to soils, particularly those of alkaline reaction, is being investigated. The need for a shaking electrode as suggested by Snyder, *Soil Sci.* XXVI, 107, is realised.

3. A study of the Bouyoucos hydrometer method for comparing the mechanical composition of soils is being made. It is hoped to correlate readings of the hydrometer with such soil constants as hygroscopic coefficient and moisture content at point of stickiness. Difficulties in obtaining uniform dispersion have been encountered, and search is being made for a suitable and rapid method.

4. A survey of the sugar-cane soils of St. Lucia, with the object of finding some indication for the low yield of cane, has been conducted. Some lime (*Citrus*) soils were also sampled. Routine estimations have been made on the samples. Acidity of many of the best soils appears to be the determining factor.

A start has been made in the study of cocoa soils, with the assistance of two post-graduate students. The method of examination is to study six-foot profiles in holes specially dug for the purpose in estates of known reputation, situated in the chief cocoa-growing districts of Trinidad. The profile horizons are sampled, and their main physical and chemical characters subsequently determined in the laboratory.

*Special Frog hopper Work.*—This has largely followed the lines mentioned in the last six-monthly report (this BULLETIN, 1928, 26, 334). The survey of Trinidad sugar-cane soils has been continued. Soil maps (texture and lime-deficiency maps) are now being constructed from available data. Special soil moisture studies are being made to throw further light on the water relations of the sugar-cane plant.

Mr. Turner reports :

1. In view of the findings briefly described in the last six-monthly report that there is a close correlation between the calcium status of soil and the resistance to frog hopper

blight of canes growing thereon, an examination has been made of the means by which improvement in the lime status of the blighted soils may most successfully be accomplished. The conclusions reached are briefly as follows :

(a) Contrary to experience in England, finely ground limestone proves a more efficient soil ameliorant than slaked lime.

(b) Single, relatively large applications of lime fertilisers give more immediate beneficial results than small annual dressings.

(c) On the heavy deteriorated soils, the effect of liming is restricted to the depth to which the soil is worked.

(d) A significant increase in crop yield is obtained only on those areas rendered neutral in reaction by liming.

2. Further researches are in progress on the extent to which certain measurable physico-chemical properties and various moisture constants of the soil are associated with its saturation capacity and lime status.

3. An investigation has been begun on the effect of climatic conditions on the amounts and inter-relationship of the various forms of nitrogen in the soil.

Other work on the froghopper problem has concerned the composition of leaves and roots of sugar-canes. Mr. Follett-Smith has been chiefly responsible for this phase of our activities, and has been aided by Mr. Rodriguez, who has analysed a large number of samples (some 130) of sugar-cane nodal tissue for accumulations of aluminium and iron compounds.

Work has been commenced on the tannin content of leaves of different varieties of sugar-cane in relation to susceptibility to froghopper blight.

## SUGAR

### *Cane*

**Leeward Islands.**—*Varietal Experiments.* The Superintendent of Agriculture reports that during the period July 1927 to June 1928 varietal experiments with sugar-cane have been continued. In Antigua, plant canes were cultivated at three stations, one on a calcareous soil, one on a volcanic soil and one on a clay soil. Unfortunately it was not possible to reap the canes from the last-mentioned plot under experimental conditions and consequently only the results from the calcareous and volcanic soil plots are available for record.

The following table shows the best varieties at these stations :

Calcareous soil.		Volcanic soil.	
Canes arranged in order of tons of cane per acre.	Canes arranged in order of lb. of sucrose per acre.	Canes arranged in order of tons of cane per acre.	Canes arranged in order of lb. of sucrose per acre.
Co. 221 Ba. 11569 B.S.F. 12/24 S.C. 12/4	Ba. 11569 S.C. 12/4 B.S.F. 12/24 M. 1237	B. 3922 B. 12 H. 109 B. 254	B. 3922 B. 12 B. 254 H. 109

Co. 221, a Coimbatore seedling introduced into Antigua in 1923 through the Indian Sugar Bureau at Pusa, yielded the highest tonnage per acre on volcanic soils during the dry season 1925-26. Under the system of experiments conducted in Antigua, where the samples for analysis are crushed in a small mill, there is always a certain unfair discrimination, as regards sucrose per acre, against such canes as the Coimbatore seedlings which are slender and possess hard rinds and high fibre content.

Ba. 11569, which has for some years been regarded as a standard variety under Barbados conditions, has given excellent results ever since its inclusion in the Antigua varietal experiments in the season 1925-26.

B. 3922 is an old favourite which has given good results both as a plant cane and as a ratoon for many seasons.

B. 12 was first included in the varietal experiments in the season 1923-24, but until the season under review showed no particular promise.

Ratoons were reaped from the two plots cultivated as plant canes in the season 1926-27. On the clay soil Co. 221 and on the calcareous soil B.S.F. 12/24 filled the first place, both in order of tonnage of cane and also in order of lb. of sucrose per acre.

Plant canes only were included in the Montserrat experiments. One of the newer Barbados seedlings, B. 374, has filled the first place both as regards tons of cane per acre and lb. of sucrose per acre.

At the Experiment Station, St. Kitts, about 200 seedlings from the B.H. 10/12 were put out in the field in October 1927. Some of these look promising, and the best of them will be selected for further trial.

Cuttings of the cane P.O.J. 2725 were obtained in April 1928. This variety is being grown at the Experiment Station under careful supervision before being distributed.

The following new seedlings have been introduced from Barbados for trial : B. 381, B. 2001, B. 8069, B. 67, B. 117, B. 268, B. 391, B. 425, B. 472, B. 603.

*Parasite Control of the Sugar-cane Moth Borer.*—Work with braconids parasitic on the sugar-cane moth borer (*Diatraea saccharalis*) described in the report for January to June 1927 (this BULLETIN, 1928, 26, 194) has been continued in Antigua, and during the year 1927 the braconids *Ipobracum* and *Microdus* were introduced from British Guiana.

These insects possess long ovipositors which enable them to lay their eggs in the larvæ of the moth borer while they are in their tunnels in the cane. The braconid larvæ live within and destroy their hosts, and instead of the moths issuing from the attacked cane their places are taken by the adult wasps whose larvæ have consumed them. The adults feed on nectar or on dilute saccharine solution, and in nature their food is the saccharine secretion of *Cordia interrupta* or some other species of *Cordia*; in captivity they may be fed on sugar or honey.

The first introductions were made by Professor Ballou, M.Sc., Commissioner of Agriculture and Professor of Entomology at the Imperial College of Tropical Agriculture. The adult braconids were transferred immediately on arrival to a large cage containing sugar-cane artificially attacked by the moth borer with the hope that they would oviposit in the larvæ of the borer, and that in this way it would be possible to establish a permanent breeding station for the parasites, which could then be liberated in infected fields of cane. The breeding cage contained also wicks of absorbent cotton saturated with a saccharine solution to serve as nutriment for the adults during the period of oviposition or before liberation in the cane-fields.

Unfortunately it was not possible to find very much infected material as a source of moth borer larvæ at the time of these importations, and moreover many of the larvæ in the artificially infected cane perished, possibly owing to rapid drying of the canes. As a result of this, while it was possible to keep the adult braconids alive for some time, no success was obtained in breeding a second generation.

In the case of later importations (four consignments were received over a period of two months) the insects were liberated in fields of young cane which were at the most favourable stage for moth borer attacks. Insects were liberated at the following estates: Collins, Gaynors, Cassada Garden, Millars, The Cotton, Gravenors, North Sound, Blubber Valley, Belvidere, Yeptons, Montpelier.

During the reaping season of 1927-28 fields in which parasites had been liberated were inspected. In no

cases were any parasites found, but an examination of the canes showed, as a general rule, a low percentage of infestation with moth borer, although in the absence of careful examination of other fields where these parasites had not been liberated, it is impossible definitely to attribute the small degree of infection to the beneficial action of these insects.

The following table shows the results of the examination of the fields infected :

Estate.	Field.	Variety Cane.	Number examined.	Percentage infested by moth borer.
Belvidere . . .	Twelve Bed.	B.H. 10/12	100	12.3
Yeptons . . .	Carbay	B. 6308	100	25.3
Collins . . .	No. 8	S.C. 12/4	100	5.1
Millars . . .	No. 7	S.C. 12/4	100	12.1
Blubber Valley .	No. 2	B. 6308	100	14.4
The Cotton . . .	No. 5	B. 4596	100	2.1

In each field 100 canes were chosen at random, and the total numbers of joints in each cane counted, also those joints showing borer holes. In this way the number of infected joints in 100 canes was determined and expressed as a percentage of the total number of joints in 100 canes.

In addition, field No. 5 at Gravenors and field No. 16 at Cassada Garden, in which parasites had been liberated, were carefully examined after the old canes had been reaped and the ratoon sprouts had made growth of 12-16 in. in height. Although the examination was made at a time when the moth borer attack is usually made, the canes were found to be remarkably healthy.

It is proposed to follow up this work with further importations of parasites, and in this connection the attorneys of two large groups of estates have offered to stand all expenses incurred in the importation of several thousand parasites for liberation on the estates under their control. The question of the successful introduction of these insects into Antigua is, however, so intimately connected with the question of furnishing an adequate supply of food for the adults that planters cannot be too strongly urged to plant *Cordias* if they desire to give the method of moth-borer control a fair trial.

## FIBRES

### *Cotton*

**Leeward Islands.**—An experiment was started in Antigua in 1927 with a view of ascertaining the time at which the emergence of pink bollworm moths is at its maximum.

A grant was obtained from the Antigua Cotton Growers' Association for the erection of a moth-proof wire cage (14 × 10 × 10 ft. with a wooden floor) in which were placed six boxes with cotton plants at the flowering stage, and a source of infection in the form of old infected bolls, refuse, seed, etc. The general scheme of the experiment was based on the idea that as moths emerged from the infected material they would lay eggs on the young bolls on the growing plants, and that by periodic examination of these bolls and determination of the degree of infection, it would be possible to arrive at some idea of the period of year at which emergences were most frequent. It was arranged to have a constant supply of young plants at the correct stage to take the place in the cage of those removed for examination, and to prevent fluctuations in the number of larvæ resting in the infected material affecting the results, it was decided to place in the cage at the start of the experiment a sufficiently large quantity of infected material to allow of the emergence of a considerable number of moths.

At first the cage was placed in a rather shady situation, which tended to prevent the cotton plants flowering and bolling, but afterwards when placed in full sunlight the plants started to set bolls, four examinations being made in February, March, April and June.

The results appear below.

*Examination for Infestation of Pink Bollworm in breeding cage at Botanic Station, Antigua, 1927-28.*

Date of examination.	No. of bolls.	Bolls punctured.	Bolls containing living larvæ.	Bolls showing larval marks.	Percentage infestation.
14.2.28	100	11	2	9	22.0
15.3.28	21	—	7	3	47.6
14.4.28	25	1	2	2	20.0
9.6.28	20	5	2	—	35.0

It is, of course, too early to draw any conclusions from this experiment, which must be carefully conducted for two or three years before results of any significance can be expected.

**Nyasaland.**—The following report by the Empire Cotton Growing Corporation dealing with experimental work on cotton carried out at the Port Herald Station has been furnished by the Chief Secretary to the Government.

**Season.**—The season on the whole was favourable to cotton, although several hot, dry spells immediately after planting in February, and later in April, tended to depress yields.

With the rotation crops the position was very different,

the long period of drought from the middle of January onwards having a serious effect on the food crops of the district.

*Field Experiments.*—These included a series of spacing experiments, variety trials and time of planting experiments :

(a) *Spacing Experiment.*—The series of trial spacings covered a range from 4 ft.  $\times$  2 ft. to 4 ft.  $\times$  6 in. No statistically significant difference in yield was obtained between the various spacings, but it would appear that a somewhat more dense spacing than that of 4 ft.  $\times$  2 ft. (one plant) would be of advantage.

The highest increases in yield over the standard of 4 ft.  $\times$  2 ft. (one plant) were given by the 4 ft.  $\times$  2 ft. (two plants) and 4 ft.  $\times$  6 in. (one plant) spacing, the calculated yields per acre being :

Spacing.	Calculated yield of seed cotton per acre: lb.				
4 ft. $\times$ 2 ft. (1 plant)	.	.	.	.	415
4 ft. $\times$ 2 ft. (2 plants)	.	.	.	.	456
4 ft. $\times$ 2 ft. (1 plant)	.	.	.	.	418
4 ft. $\times$ 6 in. (1 plant)	.	.	.	.	484

(b) *Variety Trials.*—Two series were laid down, using strains "B" and "G" and a strain "V" as standard. The final results showed a significant yield difference in favour of the "V" strain at the spacing employed (4 ft.  $\times$  2 ft.—one plant).

The calculated yields per acre were :

Strain.	Calculated yield of seed cotton per acre. lb.				
"V"	.	.	.	.	661.5
"B"	.	.	.	.	524.0
"V"	.	.	.	.	637.5
"G"	.	.	.	.	473.0

(c) *Time of Planting.*—Owing to heavy Jassid attack on the early planted cottons, the yields obtained in this series were very low, the highest being obtained from plots planted on February 17.

*Cotton Breeding Work.*—Single plant selections of strains "A" and "B" of Over-the-Top, strains "G" and "H" of Foster Whitehall, strain "N" of Arizona, and "Z" were carried on from the previous season, and, in addition, several importations of various strains were grown to provide a wider range of types for selection. The importations included a range of Cambodias, "U" 4/5, "A" 12/2, and a Durango bulk. It was considered that the addition of Jassid susceptible types, such as Durango and the resistant Cambodias, would

present an adequate range for the study of the Jassid problem. Selection in the field was based on resistance to Jassid and on good plant habit, the best of these being further selected for high ginning percentage and lint length.

The Durango and Foster Whitehall "G" strain were to a large degree a failure, due to Jassid attack. The Cambodias were inclined to be too vigorous in growth, but their high resistance to Jassid, their productivity and big, easily picked bolls made them a valuable addition to the station. Some of the more open and less lax types have been selected for planting next season.

The two importations of "U"  $4/5$  and "A"  $12/2$  gave some promising selections, with the former on the whole superior. Of the other types, strain "H" showed up well, giving selections fairly resistant to Jassid, with high productivity and high ginning percentages. In addition a large number of selections was made of the local Nyasaland Upland from various localities, the basis of selection being Jassid resistance and plant type, and the best of these will be carried on next season.

*Observation Bulks.*—Several of the more promising progeny rows from the previous season were grown as bulk observation plots, the yields and lint characters being as under :

Serial No.	Yield per acre. lb.	Lint length. mm.	Ginning percentage
H-3-2	710	29.5	33.3
H-2-2	1,224	28.6	35.2
H-3-8	775	28.92	29.8
26 G-35	435	28.50	34.3
26 G-48	437	28.36	36.2
G-15-8	467	27.76	32.6
G-1-7	358	27.98	35.8

The three plots of strain "H" showed a much higher degree of Jassid resistance than strain "G," which was the main cotton of the station, and in addition, the yields were much higher. H-2-2 will be grown as the bulk cotton of the station next season to replace the "G" strain.

*Insect Pests.*—The three major pests of cotton during the season were Bollworm (Red and American), Stainer and Jassid.

(a) *Bollworm.*—The three types of bollworm (red, American and spiny) were present during the season, but the attack of spiny bollworm was not of major importance. Destruction of bolls by this type was inconsiderable compared with that of the red bollworm and, particularly in the earlier part of the season, the American bollworm. From the evidence of continuous daily records, augmented

by field observation, it was seen that the American bollworm was of very considerable importance, the loss through this type being higher than that by red bollworm up to the end of May. By June the numbers of American bollworm decreased greatly, and this seasonal incidence of the pest is a strong argument in favour of late February planting in this area. The red bollworm was present through the season, but more particularly in the earlier part, and presents to some extent the same problem.

As late planting as possible, consistent with the crops' requirements, is to be recommended, and observations of the incidence of the bollworms appear to indicate that a method of trapping, using strips of early planted cotton, would be of value.

(b) *Stainer (Dysdercus spp.)*.—During the season stainer was responsible for heavy losses of potential crop, the damage ascribable to this cause being estimated as equal to the loss by bollworm. The insects were present throughout the season, but the really heavy immigration occurred in early June.

Traps of whole cotton seed were tried, but proved of little value in attracting the insects. Owing to the large amount of damage due to the pest, it is felt that some scheme of trapping would be of value if sufficient attraction could be given to the insect. A method which will be tried next season is that suggested by E. Ballard and M. G. Evans (*Bull. Ent. Res.* XVIII, Part 4, p. 405) of providing suitable moulting places for the gregarious 5th instar nymphs.

(c) *Jassid*.—This pest had been observed on the station the previous season, but the attack reached a greater intensity this year, due in great measure to the presence of susceptible strains and the presence of early planted cotton. It would appear that under conditions favourable to the pest, Jassid may be a factor of great importance in cotton cultivation, and one of the main aims in the breeding work is the selection of resistant types.

*Rotation Crops*.—The season was an unfavourable one as far as crops other than cotton were concerned, the cereals in particular being very adversely affected by the hot, dry periods in February and March. Of the bulk rotation crops the most successful were ground-nuts and bush Lima beans.

(a) *Ground-nuts*.—The variety grown was "Spanish Bunch," and, though in appearance the crop seemed to be affected by the dry periods, the yields obtained were good—1,200 lb. per acre in one field and 1,500 lb. in another.

(b) *Bush Lima Bean*.—This has proved a very success-

ful addition to the pulse crops of the station ; the crop stood up well to the dry periods and a yield of 660 lb. per acre was obtained. Planting was done in December in fairly wide rows, and a second planting in March between the rows. This double planting proved a successful practice.

(c) *Sunn Hemp*.—In the previous season Sunn hemp made good growth and was a useful cover crop. Growth this season was not very good, and owing to a very heavy infestation of a *Lygæd* bug, which punctured the young pods, little seed was harvested—barely equivalent to the seed rate.

(d) *Nandolo (Pigeon Pea)*.—Growth was much less than in previous years and the yield was decreased. In addition to this local variety, a variety from Kenya was tried as a small observation plot. Under the conditions of the Makwapala station, this variety has proved much superior to the native type, both in growth and yield, but at Port Herald this season it was decidedly inferior to the native variety.

In addition to these bulks, a large number of potential rotation crops was grown in small plots. The cereals gave nothing of particular value, but several of the pulses were promising, particularly green gram and two species of *Canavalia*. The green gram yielded well, and on account of its quick maturity it is greatly in favour with the natives. The *Canavalias*, though planted rather late, proved to be a very good cover crop, while a purple-leaf type of *Dolichos Lablab*, also obtained from the Imperial College of Tropical Agriculture, Trinidad, was superior in yield to the native type.

**Swaziland.**—The following report on the work carried out at the Cotton Experiment Station, Bremersdorp, Swaziland, during the season 1927–28, has been furnished by Mr. R. McDonald, Cotton Specialist to the Swaziland Government.

*Site of Station.*—Brief mention was made by Mr. R. C. Wood in his report for season 1925–26 on the undulating nature, and the lack of soil uniformity, in the land used for his experimental work at Bremersdorp. For this reason it was decided not to utilise the land on which he carried out his experiments, but to try to obtain a more uniform area of land elsewhere. With the assistance of Mr. F. S. Parsons, Cotton Officer, Zululand, a plot of land on Mr. P. J. Lewis's farm in the Matapa District was decided on for use during the season.

The land is situated six miles from Bremersdorp, the headquarters of the Cotton Specialist, at an altitude of

2,200 ft. This is probably the upper limit for cotton growing, but as the surrounding district is the most closely settled cotton-growing area in Swaziland it is felt that this alone justifies its position as a Cotton Experiment Station.

The soil is medium red loam and, apart from the fact that it tends to cake after heavy rain, has proved satisfactory.

*Season and Climatic Conditions.*—The past season opened most promisingly, good rains during July and the early part of September permitting most of the cotton lands to be winter ploughed. This was followed by heavy rains in the latter part of October, with the result that the bulk of the cotton crop was planted by the middle of November.

The early progress of the crop in the middle-veld was slow. Low temperature accompanied by strong winds retarded growth considerably, and it was not until the advent of higher temperatures and better conditions towards the middle of December that any appreciable growth was made.

The total rainfall for the season over the greater portion of the cotton area would have been sufficient for the requirements of the crop had its distribution been more even. Unfortunately its distribution was most erratic, in some cases 16 in., or more than half the rainfall registered during the season, fell in the first fortnight of January. Following the heavy January rains came the drought of February and March, felt most severely in the Lebombo and White Umbuluzi areas, and only partially relieved by light showers in April. The Bremersdorp area did not suffer to the same extent during February and March. A good rain in the last week of March, followed by another in the early part of April, resulted in a good late crop being established. On the whole, the past season has been more satisfactory than the two previous ones, and afforded an opportunity of observing the behaviour of the new Jassid resistant strains under flood and drought conditions.

*Variety Trials.*—Seed of seven jassid resistant selections was supplied by Mr. F. R. Parnell, Cotton Breeding Station, Barberton, for use in this experiment. The strains to be tested were numbered B. 143, B. 179, B. 180, A. 12 and Z. 1-9. In the past the bulk of the cotton grown in Swaziland has been an upland variety, locally known as Uganda, which is susceptible to jassid. This cotton was included in the trial both as a jassid control, and for comparing the yield of the jassid resistant strains with the

yield of the local cotton, when grown under the same conditions. The seed used was grown under drought conditions at Barberton the previous year, and apart from Uganda gave a very low germination percentage. Germination tests on the seed gave the following results :

Variety.	Germination. <i>Per cent.</i>	Variety.	Germination. <i>Per cent.</i>
Uganda	76	A. 12	58
Z. 1-9	56	B. 179	54
B. 180	52	U. 4	52
Z. 49	50	B. 143	45

The experiment was laid out in four adjacent blocks in plots of four rows, 80 ft. long and 3 ft. 6 in. apart,  $\frac{1}{10}$  acre. Each strain was repeated eight times, with four rows of the strain Z. 1-9, which was used as a standard, on each side of it. All the seed was delinted by sulphuric acid previous to planting. Planting was done on October 25 to October 28, one block containing two repetitions of each strain being planted per day. Lack of an adequate supply of labour prevented the whole experiment being planted in a shorter space of time.

Conditions at the time of planting were favourable to good germination, but heavy rains on October 28 and 29 followed by dry winds caked the surface of the soil, making it difficult for the seedlings to rupture the crust formed. Replanting the blanks, accompanied by hand watering, resulted in a fairly uniform stand being obtained for all the jassid resistant strains, with the exception of B. 143. The stand on the B. 143 was not so good on account of the bad germination of the seed. The better germination of the Uganda seed produced a much better initial stand than any of the other strains, and the growth and development of this strain were ahead of all others during the early part of the season.

Picking was begun on April 25 and continued at intervals of fourteen days, the yields from each row being picked and weighed separately. The total yields are as follows (Table I) :

TABLE I

Variety.	1st pick. <i>lb. per acre.</i>	2nd pick. <i>lb. per acre.</i>	3rd pick. <i>lb. per acre.</i>	4th pick. <i>lb. per acre.</i>	Total yield. <i>lb. per acre.</i>
U. 4 . . .	570	266.5	173.5	45.5	1055.5
A. 12 . . .	291.5	176.5	196	63	727
Z. 1-9 . . .	211	178	182	64	635
B. 143 . . .	140	159	171	78.5	548.5
Uganda . . .	325.5	123	75.5	20	544
B. 179 . . .	164.5	128.5	128.5	60	481.5
Z. 49 . . .	110	117.5	157.5	62.5	447.5
B. 180 . . .	162.5	110.5	113	35.5	421.5

In examining the results, the yields of two row totals of each variety were compared with two rows of the adjacent standard Z. 1-9, thus giving sixteen comparisons with the standard for each variety. The results are summarised in Table II, the varieties being placed in the order of merit.

TABLE II

Variety.	Yield per acre.	Mean yield per half-strip.	Mean difference from adjacent standard Z. 1-9.	Standard error (E) of mean difference.	Mean difference (E).
	lb.	lb.			
U. 4 . . .	1055.6	211.1	85.1	8.49	10.02
A. 12 . . .	727	145.6	24.7	5.6	4.4
Z. 1-9 . . .	635	127.0	—	—	—
B. 143 . . .	548.5	109.7	-28.7	8.88	3.12
Uganda . . .	544	108.8	-20.3	5.83	3.5
B. 179 . . .	481.5	96.3	-40.8	7.15	5.7
Z. 49 . . .	447.5	89.5	-34.3	6.10	5.7
B. 180 . . .	421.5	84.3	-48.3	8.55	5.7

The difference in yield between each of these varieties and Z. 1-9 is highly significant. In each case the mean difference, as compared with the standard error, is such that the odds are more than a hundred to one against such a result arising from chance. Two varieties, U. 4 and A. 12, have both shown an increased yield over the standard, while the other five show a decrease on the standard.

The comparison of the difference in yields between U. 4 and A. 12 is given in Table III.

TABLE III

Variety.	Mean of single row. or.	Variance of mean of 32 rows.	Mean difference.	Standard error of mean difference.	Mean difference (E).
U. 4 . . . . .	105.5	25.24			
A. 12 . . . . .	72.8	17.57	32.7	6.54	5

The mean yield per single row of the U. 4 taken from all the eight plots, compared with the mean yield per row of A. 12, gives a difference of  $3 + 32.7$  in favour of the former. This difference has a standard error of 6.5, so that it is five times as large as its standard error, and is highly significant, the probability that it is due to chance being less than one in a hundred. The results show that although three of the strains tested, B. 179, B. 180, Z. 49, gave a decreased yield compared with Uganda, three of the strains, Z. 1-9, A. 12, and U. 4, represent definite successive improvements in yield on Uganda, each being successively better than the one before in the order named.

An examination of the yield figures shows that U. 4

and A. 12, in addition to producing the biggest yields, are much earlier than the other jassid resistant strains. The importance of being able to grow a jassid resistant strain which, in addition to being a heavy cropper, is also an early maturing cotton, cannot be under-estimated in a country where a great proportion of the cotton reaped late in the season suffers considerable damage from stainer.

That the local Uganda produced 82 per cent. of its crop in the first two pickings is due to the fact that jassid attack prevented all but early formed bolls from maturing.

The strain Z. 1-9 is a very uniform type, but tends rather to over-production of wood. It produces a big boll which opens well, and will probably do better with a wider spacing than was used in the trial. U. 4 is not so uniform in that it contains a number of different types, all of which offer promising material for further selection. It is a small balled type, fruiting prolifically even under adverse conditions, but in the above experiment it did not open its bolls well. A. 12 is a much smaller type than either of the above. It fruits well, producing good-quality lint, and opens its bolls well. B. 143 is a medium-sized type with characteristic grey-green foliage. It opens its bolls badly, making picking very difficult and expensive. The lint length is quite good but the ginning percentage is low. Both Z. 49 and B. 180 are not quite suitable for dry-land farming under conditions of precarious rainfall, although B. 180 might merit further trial on irrigated land.

With the exception of B. 180, Z. 49 and Uganda all the varieties showed as high a standard of resistance to jassid as would be required when grown under field conditions. A. 12 proved itself the most resistant of all the varieties, but both Z. 1-9 and U. 4 showed as high a degree of resistance as would be required in actual practice. Apart from Uganda, which succumbed early, Z. 49 was the first to show symptoms of jassid attack, but towards the latter part of the season B. 180 appeared to suffer more than Z. 49.

The lint characters and boll weights of the above varieties are given in Table IV.

TABLE IV

Variety.	Boll weight.	Ginning percentage.	Weight of 100 seeds.	Lint length.
	<i>gms.</i>		<i>gms.</i>	<i>mm.</i>
Z. 1-9 . . .	6.2	32.6	11.5	27.1
Z. 49 . . .	5.9	32.5	12.5	25.1
Uganda . . .	4.7	32.8	9.2	25.0
U. 4 . . .	4.8	37.0	9.4	29.7
A. 12 . . .	6.0	34.7	10.5	28.0
B. 143 . . .	6.2	30.4	12.8	28.6
B. 179 . . .	6.1	34.1	12.8	26.8
B. 180 . . .	7.4	33.0	14.1	26.6

*Observation Plots.*—Quarter-acre plots of the strains used in the Variety Trial were laid out with the kind co-operation of farmers in different areas.

At *Dinedor* the plots were planted out in lands owned by Mr. G. L. Wallis situated in the lower middle veld on the banks of the Umbuluzi River. The plots were planted on November 29 under excellent moisture conditions, and all the varieties germinated well. Unfortunately the stand was completely destroyed by a sand-storm which took place about a week after the cotton had germinated, and the plots were abandoned.

On the estate of the *Swaziland Corporation Plantations*, which is situated on the low veld and is considerably hotter and drier than Bremersdorp, the varieties were planted in rows 3 ft. 6 in. apart, with the plants 2 ft. apart in the rows. The work was kindly undertaken by Messrs. Stapleton and Jennings. Conditions at the time of planting were not good; the plots were planted on November 24 following light showers and did not receive a soaking rain until January 5. Germination was bad, the final stand being less than 50 per cent.

Conditions throughout the season were bad; the total rainfall registered on the Estate during the year amounted only to 17.65 in., and of this amount 7.61 in. fell in the three months prior to planting.

The varieties U. 4, A. 12 and Z. 1-9 have again demonstrated their superiority over the others, and have shown that they will produce a paying crop despite adverse conditions. In the final yields the varieties follow closely their order of merit in the variety trial. U. 4, A. 12 and Z. 19 have again produced the heaviest crop in the order named, while B. 180 and Z. 49 come at the foot of the list.

The total yields are given in Table V.

TABLE V

Variety.					Yield in lb. per acre.
U. 4 .	.	.	.	.	880
A. 12 .	.	.	.	.	640
Z. 1-9 .	.	.	.	.	580
Uganda .	.	.	.	.	456
D. 143 .	.	.	.	.	380
B. 179 .	.	.	.	.	292
B. 180 .	.	.	.	.	252
Z. 49 .	.	.	.	.	172

*Spacing Experiment.*—The following experiment was laid out to test a jassid resistant strain numbered Z. 106 at two different spacings. The spacings used were:

1. Plants 6 in. apart in the rows with rows 2 ft. 6 in. apart.

2. Plants 6 in. apart in the rows with the rows 3 ft. apart.

The yields were compared with that of Z. 1-9, which was planted in rows 3 ft. 6 in. apart with the plants 1 ft. apart in the rows. The plots used were four rows 80 ft. long; each spacing was repeated eight times with the standard on each side of it, giving sixteen comparisons with the standard for each spacing on the half-strip method.

The method of analysis of the results is the same as that adopted in the variety trial. The results are summarised in Table VI.

TABLE VI

Variety.	Spacing.	Yields per acre.	Mean yield per half- strip.	Mean differ- ence from adjacent standard Z. 1-9	Standard error (E) of mean difference.	Mean dif- ference.
		lb.	oz.			
Z. 106	2 ft. 6 in. by 6 in.	442	92.4	12.3	5.13	2.4
Z. 1-9	3 ft. 6 in. by 1 ft.	352	70.4	—	—	—
Z. 106	3 ft. by 6 in.	364.5	78.3	5.1	5.26	0.97

Z. 106 at a spacing of 3 ft. by 6 in. shows a decreased yield per acre as compared with the standard, but the mean difference, as compared with the standard error, is too small to be significant. The yield per acre at a spacing of 6 in. in the rows with the rows 2 ft. 6 in. apart shows an increase on the standard. The mean yield per two rows of Z. 1-9 gives a difference of 12.3 in favour of the former. This difference is 2.4 times as large as its standard error and is significant, the probability that such result should rise from chance being less than 5 per cent.

Z. 106 is a compact, upright type with short fruiting branches, making it eminently suitable for very close spacing. It fruits and holds its bolls well, but opens its bolls badly, so that it is difficult and expensive to pick. Apart from the variety A. 12 mentioned in the variety trial, it showed itself more jassid resistant than any other variety grown on the station. Examination of the yields of the different pickings (Table VII) shows Z. 106 as being considerably earlier than Z. 1-9.

TABLE VII

Variety.	Spacing.	1st pick. lb. per acre.	2nd pick. lb. per acre.	3rd pick. lb. per acre.	Totals. lb. per acre.
Z. 106	2 ft. 6 in. by 6 in.	299.5	99.5	43	462
Z. 1-9	2 ft. 6 in. by 1 ft.	177	95	80	352
Z. 106	3 ft. by 6 in.	249.5	75	40	364.5

The lint measurements and boll weights are given in Table VIII.

TABLE VIII

Variety.	Boll weight.	Ginning percentage.	Weight of 100 seeds.	Lint length.
	<i>gms.</i>		<i>gms.</i>	<i>mm.</i>
Z. 106 . . . .	4.3	34.3	9.7	27.3

*Seed Multiplication.*—The first general issue of seed of jassid resistant strains was made at the commencement of the past season, with Z. 1 bulk seed, multiplied under Mr. R. C. Woods's supervision during the previous season; parcels of seed 25 lb. and upwards were distributed to applicants. On the majority of farms the seed was planted by hand, at wide spacings, with a view to further rapid multiplication. The results were very encouraging; in many cases farmers who were issued with 25 lb. of seed have returned 1,200 to 1,700 lb. of seed cotton of re-selected Z. 1 to the ginnery.

Arrangements were made with farmers in widely separate areas for the multiplication of 2,000 lb. of Z. 1 seed, for general distribution during the coming season.

The amount of seed returned to the ginnery from this multiplication is in the neighbourhood of 35,000 lb. This amount would have been considerably more had not the multiplication areas on three farms suffered severely from adverse climatic conditions and bollworm attack. Mr. G. L. Wallis, in the White Umbuluzi district, had half his multiplication area destroyed in a sand-storm in the early part of the season, while the stand on the other half was reduced considerably. The plots on the farms of Mr. P. J. Lewis and of Messrs. Holland and Jennings both suffered severe damage from bollworm attack. The attack was most severe on Messrs. Holland and Jennings's farm, and when it is considered in addition that the crop was grown with a rainfall of only 17.65 in., the return of 500 lb. seed cotton per acre is remarkably good. This seed was distributed to growers in Swaziland, and along with the bulk seed should ensure that the greater part of the cotton area will be under jassid resistant strains during the coming season.

Multiplication of seed of the U. 4 strain, which has proved itself a prolific cropper in every district in which it has been tried, will be done during the coming season. Arrangements have been made, with the kind co-operation of the farmers, for the seed to be grown on both dry and irrigated land, and provided the season is good, sufficient seed of this variety will be obtained to give every grower a small amount the following season.

*Rotation Crops.*—The small area of land available precluded any serious tests being attempted, but small

plots of different crops which might prove useful for rotation with cotton were planted. Apart from cotton, the main crops grown in the Territory in the past have been maize and kaffir corn, both of them finding a ready market locally at satisfactory prices. The local demand for maize has fallen off considerably during the past year, and the adoption of better methods of cultivation by the native population, coupled with the increasing number of natives employed on farms, public works, etc., will tend to diminish the demand in future. The present cost of transport practically prohibits the growing of maize for export purposes, and it is very necessary to find other rotation cash crops which can be exported at satisfactory prices.

Seed of seven varieties of South Indian *Sorghums* was obtained from Mr. Parnell and planted in the middle of November. Growth in all varieties was very vigorous, but all proved very susceptible to rust. All except two varieties, which were not so badly attacked by rust, were ratooned back to ground level in January, but both the ratooned and the other two varieties failed to give a crop.

*Ground-nuts* offer more prospects of being a suitable rotation crop on the lighter soils. It is a hardy crop, stands drought well, and has a good export value. The common variety grown in Swaziland is Virginia Bunch, an upright type which has given good results under suitable conditions.

Fifteen varieties were grown in small plots, and although no outstanding yields have been obtained, they will all be given a further trial on a bigger scale in the coming season. The best yields were obtained from some of the spreading types, but the reaping costs of the spreading varieties are so much higher than that of the upright types, that it may prove more remunerative to grow a lower-yielding upright type in preference to the higher-yielding spreading variety.

With regard to *Beans and Pulses* the prevalence of the Cantharides or the C.M.R. beetle limits the planting of these crops for seed purposes. The danger from this source can be lessened by planting early in September, provided the rains are early, or by delaying planting till January. Various types were planted during January and February. *Phaseolus Mungo* grew well, but suffered from a weevil pest which attacked both flowers and unripe grain. Three varieties of soya beans were grown, and of these a commercial variety, "Yellow," promises well. Tepary beans succumbed completely to collar rot. Two varieties of pigeon pea (*Cajanus indicus*) obtained from Bihar, India, were planted out in December. Both appeared to suit

local conditions, and gave yields of 800 lb. and 1,000 lb. per acre respectively. Reports on samples sent to the Johannesburg Market quote the price as £1 12s. 6d. per 200 lb. From observations it would appear that planting before December would result in a higher yield being obtained. The Hluba bean (*Voandzeia subterranea*), which has given good results elsewhere, failed completely on the red soil.

*Insect Notes.*—Jassid appeared soon after the January rains, and by the beginning of February its effect on the crop was very noticeable, the attack gradually increasing in severity until the end of March. The greatest damage was done by the pest in the low-velde areas, where the period of infestation coincided with the drought of February and March. In the Bremersdorp area the attack was not so severe and the late rains revived the crops.

The incidence of *bollworm* attack during the season has been very slight, although a few individual farms suffered severely from red bollworm.

The American bollworm (*Chloridea obsoleta*) attained no importance, although occasional larvæ were found during the early months of the season. The same may be stated with regard to spiny bollworm (*Earias insulana*). Considerable numbers were destroyed in trap crops of cotton in the White Umbuluzi District during September and October, but little damage was done to plant cotton throughout the year.

As mentioned above, only a few individual farms suffered from red bollworm (*Diparopsis castanea*). Its presence on cotton grown on the Station was noted as early as December 5, but the increase in numbers was very small until the middle of March, when a heavy infestation took place. Later in the season the pest disappeared and little damage to the late crop was recorded.

Trap crops of ratooned cotton were utilised on two farms, the cotton being hand stripped or grazed back by cattle during the early part of the season, when the bollworm conditions justified it. Little can be said of the benefit derived by the plant cotton on the farms where the trapping was carried out, on account of the slight amount of the damage done by the bollworm in the past season.

## MINERAL RESOURCES

### BRITISH GUIANA

THE Director of the Imperial Institute has received from the Commissioner of Lands and Mines, British Guiana, the following report by Mr. Smith Bracewell, on recent

investigations by the Geological Survey of British Guiana. Since the last report was submitted, geological investigations have been conducted by this Survey in the Potaro goldfield and in the Mazaruni diamond field.

*Gold.*—The work in Potaro was concerned with a consideration of the gold reserves of the district, particularly with the feasibility of the exploitation of the auriferous laterites which occur extensively in this field and from which it is now seen that the bulk of the placer gold in this district has been directly derived. (The term laterite is used tentatively for rocks having the physical appearance of laterite, but which have not, as yet, been analysed.)

The laterite occurs as the capping of the numerous low, flat-topped hills, which are apparently the remnants of a dissected, formerly more or less continuous plateau, situated four to five hundred feet above present sea-level, and on the surrounding hill slopes. It extends as a broad selvedge about three to four miles wide around the igneous massifs of Ebini, Eagle and Look Out Mountains and contains gold values, more particularly in the vicinity of the Eagle Mountain range, where the geological conditions governing the occurrence of gold are developed. In the vicinity of the mountains it rises and merges with scree and alluvial fans of lateritic gravel on the mountain sides, whilst to the north it passes, along a fairly well defined junction, into extensive deposits of white sand.

The deposit consists chiefly of lateritic gravel, often cemented into boulders and masses which give rise to the solid vertical walls and encrustations of the top of the small plateau. Less cemented sections exposed by excavations occasionally show a slight stratification. The deposit is about ten to twenty feet thick in the worked open cuts, but is probably thicker closer to the mountains. It rests upon a fairly well-defined mottled pink, white and red clay bedrock, and often contains numerous flat, apparently water-worn pebbles of bauxite of the following general composition. The following analysis by M. S. Bender is given by courtesy of the Demerara Bauxite Co. :

Loss on ignition.	SiO <sub>2</sub> .	TiO <sub>2</sub> .	Fe <sub>2</sub> O <sub>3</sub> .	Al <sub>2</sub> O <sub>3</sub> .
31.75% to 32.51%	0.23% to 2.35%	1.20% to 3.85%	2.12% to 6.16%	59.89% to 61.88%

The deposit had been regarded as residual on basic igneous rocks, but it became evident during these investi-

gations that much of it was detrital or alluvial in origin. It may be related in origin to the deposits of gravelly white sand which cover large areas of the dissected marine plain which extends from the mountain foot to the Atlantic coast and for which a fluvatile or fluviomarine origin has been postulated. (Rep. Prel. Geol. Surv. Potaro-Ireng Dist. of B.G., by S. Bracewell, 1927.) The nature of the occurrence suggests that it was laid down along the shore line of this plain during the same submergence.

Work was carried out to determine whether the gold values in the laterite were sufficiently high to permit of its exploitation by hydraulicing. The results have been disappointing in this respect. The values are found to vary from 2*d.* to 10*d.* per cubic yard in the "in situ" laterite, with an available reserve of 1,300,000 tons averaging 6½*d.* per cubic yard in one portion of the area.

The slope wash is usually richer with values of 10*d.* to 1*s.* 8*d.* and even 3*s.* 4*d.* per cubic yard where slightly concentrated by rain wash. These richer portions have been almost exhausted by hand methods, operations having been commenced in the numerous gullies and creeks and extended up the laterite slopes to the limit of profitable exploitation. The work has been limited by the nature of the water supply. Where a good supply of water was available for ground-sluicing, deposits averaging 7½*d.* per cubic yard upwards have been and are still being worked by small parties of native miners; but more often the work has been discontinued with values of 1*s.* 3*d.* to 3*s.* per cubic yard remaining, due to the limited water supply necessitating treatment by more expensive methods. These deposits are not, individually, sufficiently extensive to warrant the introduction of hydraulicing plant.

Hydraulicing costs at the old Tassawini and Omai mines were 12 and 22 cents per cubic yard in soft material varying in depth down to 100 ft. or more. Costs would certainly be higher in the shallower cemented deposits of laterite in the Potaro district, unless a natural head of water could be procured, which appears unlikely.

In view of this, hydraulicing of this deposit is impracticable. The rich spots in the slope wash amenable to hydraulicing are too shallow and restricted in extent, being separated by highly cemented laterite, far too low in gold content to allow of profitable exploitation.

*Gold-dredging Reserves.*—Dredging has been carried on in the Mahdia creek continuously since 1914, by the Minnehaha Development Company utilising a dredge of 3 cub. ft. bucket capacity of the New Zealand single-lift sluice type. Approximately 190 acres of ground have

been worked of an average depth of 14 ft., producing 34,000 ounces of gold (an average yearly production of 2,428 ounces) from ground yielding roughly 1s. 3d. per cub. yd. Dredging proceeded up the creek from a point close to 8 miles on the Potaro Road and has now reached a point near 11½ miles on the same road. Between this point and 14 miles, it is estimated, there are 110 acres of dredgable ground. Assuming that this carried gold values equivalent to that already worked there is a possible reserve of about 20,000 ounces of gold.

During the survey of the district a short examination was made of the lower portion of the Mahdia River. There are two low falls in this river, one about half a mile below where dredging was commenced and the other about one and a half miles further downstream and about four miles from the mouth of the river. Between the lower fall and its mouth the river has developed wide flats with alluvial deposits from 9 to 16 ft. deep in observed sections. The shallower and more easily worked parts of these away from the river have been extensively worked by hand methods.

Tests were made in these flats on the right bank of the creek. The average value obtained from fifteen pits was only 14 cents (7d.) per cubic yard. This figure is far too low, of course, to allow of profitable dredging. The amount of prospecting was quite inadequate to justify any definite conclusion, and the creek may be recommended for further investigation by persons interested in the development of dredging projects in the colony.

*Diamonds.*—A systematic examination has been carried out of that part of the Mazaruni-Puruni diamond fields situated between 59° 50' W. and 60° W. longitude and 6° 5' N. and 6° 20' N. latitude, covering an area of about two hundred square miles between the Mazaruni and Puruni Rivers. It was only possible to spend thirty-three working days in the area, during which period some three hundred miles of line were surveyed. The area was covered by cross lines at about mile intervals from two main lines commenced six miles apart on the Mazaruni River.

The main objectives of the examination were to obtain information as to the distribution and mode of occurrence of the diamond-bearing gravels, which might throw light on the origin and geological history of the deposits, such information being useful in a consideration of the resources and probable future development of the diamond industry.

The map of the area being prepared indicates to some extent (1) exploited and unexploited areas; (2) worked and unworked portions of the exploited areas; (3) probably

barren and possibly diamantiferous portions of the unexploited area. The possible diamantiferous portions will be determined by considerations relating to the geology and physiography of the area. They should be supported later by prospecting work in the areas recommended. The amount of prospecting carried out during the survey was limited by the demands of the main programme and by the time available. Outside the exploited area, discoveries were made only in Appiu creek, a tributary of the Pashanamu and Puruni Rivers. A few diamonds were found in the area of exploitation.

The exploited area covers about forty-six square miles or about one-quarter of the area examined. Between the Redhill loop of the Mazaruni and the Oranapai or Mapuru River the workings extend back about five miles from the Mazaruni River. To the north, the area becomes restricted to a belt about two miles wide which trends roughly north-east for a distance of about fifteen miles from the river and joins the Puruni workings at Arabagai, which are outside the area examined. The workings are located within this area in extensive white sandy clay flats separated by low hills of brown or red sandy clay.

A noticeable feature of the gravels in these flats is the extremely small proportion of water-worn pebbles, the gravel consisting chiefly of white and light-brown angular quartz, much of which is derived locally from stringers in the underlying white clay bedrock. This feature contrasts sharply with the preponderance of water-worn pebbles in other parts of the Mazaruni-Puruni field and in the Potaro field. The deposits are located less than 100 ft. above the Mazaruni River and less than 200 ft. above sea level. No hill deposits were observed in the district such as occur in other fields. The deposits are entirely alluvial. The restricted distribution of the diamonds must be related to the distribution of the original deposits from which the diamond is derived. Their source may be represented by adjacent "in situ" rocks, or the belt may be the site of older alluvial deposits, remnants of which might be discovered at higher levels. In the absence of discoveries of diamonds in the bedrock or residual deposits in the area, and in view of the proved source of the diamond in other areas, the second alternative is accepted and it is assumed that the north-easterly belt represents the site of alluvial deposits laid down at a height exceeding 200 ft. above sea level. Remnants of these deposits were not encountered during the examination. It would appear that denudation of the area by Mazaruni and Puruni tributaries has removed the bulk or all of these deposits and has left behind the heavier

diamond concentrates in the channels eroded in the underlying bedrock. Accepting this hypothesis it is evident that diamonds may be found in all localities likely to receive contributions from the older alluvials.

It is not surprising then that the large area lying to the immediate north-west of the diamond belt, with granite and gabbro hills rising often to 300 ft. and in places to 700 ft. above sea level, has so far proved quite barren of diamonds. It will probably continue to do so. But it is difficult to understand the absence of workings in the large area to the immediate south-east of the belt, i.e. in the Sipari River area; and why, although practically all the headwater tributaries of the Oranapai River are diamantiferous, there are few if any workings on the eastern bank of the river in the lower three miles of its course.

*Mineral Oil.*—Considerable interest continues to be evinced in the possibility of the discovery of petroleum in the coastal alluvial belt, although the fourteen artesian wells recently put down in the Berbice and Courantyne districts to depths varying from 600 to 1,082 ft. have provided no additional grounds for optimism. The position remains the same as that outlined by the late Sir John B. Harrison in his "Digest of the Results of the Enquiries made concerning the Occurrence of Petroleum and of Pitch in the Colony," *Sessional Paper*, 1925.

*Manganese.*—Engineers carrying on road-making experiments in Georgetown are utilising as road metal a manganiferous laterite, samples from which, assayed in 1918, gave the following percentages of  $MnO_2$ :

From depth of 8 feet	.	.	.	32.94 per cent.
" " " 12 "	:	:	:	24.40 " "
" " " 18 "	.	.	.	33.65 " "

It is hoped that richer ore will be encountered during the excavations for the road metal.

*Rutile and Zircon.*—Concentrates from placers in the Berbice district submitted by J. C. Menzies were found to contain a high proportion of rutile and a small proportion of zircon. A sample of the rutile concentrate submitted by Messrs. Geddes Grant to the High Speed Steel Alloys Co., Ltd., Ditton Road, Widnes, gave the following composition:

$TiO_2$	.	.	.	.	.	95.00 per cent.
$Fe_2O_3$	.	.	.	.	.	1.95 " "
$SiO_2$	.	.	.	.	.	2.94 " "
P	.	.	.	.	.	0.08 " "

Small concessions have been granted to enable further prospecting to be carried on, but so far no further develop-

ment has been recorded. North American pigment producers are said to be interested.

*Magnesite.*—Specimens of concretionary magnesite have been brought down recently from the Rupununi district. The locality of origin is considered too remote to allow of exploitation.

### NIGERIA

The Director of the Imperial Institute has received from the Director of the Geological Survey of Nigeria (Captain R. C. Wilson) the following report on the work of the Survey during the period August–December, 1928.

*Gold.*—No further field work has been done since the despatch of the last half-yearly report. Slides have been made of the more typical rocks of the area and examined microscopically, and the various concentrates collected during the season investigated. These show the usual minerals to be expected from the debris of a crystalline area.

*Coal.*—The samples of coal examined at the Imperial Institute earlier in the year have been definitely proved to be lignitic in composition, though they bear no resemblance in outward appearance to the lignites of the Lower Niger valley. It is probable that this lignite is intermediate in age between the Cretaceous coals at Enugu and the lignites of Okpanam and Newi, and may belong to that series of beds described from further south as the Carbonaceous and Pebbly Sandstone Group.

*Oil.*—A sample of crude oil was forwarded to the Imperial Institute during the year for examination and report. The results of the analysis show that this is an oil of high specific gravity and of fair quality. Samples have been submitted for further examination, while a detailed field examination will be made of the locality early in the coming season.

*Water Supply.*—As a result of the evidence gained during the preliminary geological examination of some of the more important waterless and uninhabited areas of Sokoto, it has now been decided that the Geological Survey should organise and control a well-sinking campaign in that Province. Evidence points to the fact that, though it is improbable that artesian supplies will be obtained, there are ample supplies of sub-surface water, sufficient at least for domestic supplies for man and beast, at readily accessible depths. Accordingly, proposals were put forward for the formation of a water supply section of the Department to carry out this work, and these have now received the approval of the Secretary of State. This

Section will be under the control of an Assistant Director, Geological Survey, who will have with him an engineer and a foreman, while geologists from the staff will be attached as and when necessary to carry out investigations.

The aims and objects of this Section may be summarised thus :

1. The preliminary examination for all water-supply schemes, whatever their nature.

2. Experiments to ascertain the most suitable methods of sinking and lining wells and of raising water from them.

3. The sinking of wells and to some extent the upkeep of the deeper ones, and investigations into methods of improving existing shallow wells.

4. Experiments in sub-surface dams.

5. The accurate recording and correlation of all strata in wells and boreholes.

6. The collection and correlation of data regarding water supply, flow of rivers, rate of flow of water into wells and boreholes, and amounts available, rainfall, evaporation and run-off.

7. A close investigation of the all-important question of desiccation.

8. A study of the present-day river systems in the more arid parts, their relations to those of the past, and the bearing of the changes that have taken place on the present-day conditions.

9. Investigations as to the suitability of bored wells in certain sites.

The work that is of immediate importance is the sinking of wells in Sokoto ; this will be commenced in the coming field season and extended to Bornu as soon as possible.

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## ABSTRACTS OF RECENTLY PUBLISHED LITERATURE ON AGRICULTURE AND FORESTRY

*In this section a summary is given of the contents of the more important recently published papers and reports relating to tropical agriculture and forestry. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.*

### AGRICULTURE

#### FOODSTUFFS

**Cocoa.**—An account of witch-broom disease has been written by F. Stell (*Bull. Dept. Agric., Trinidad and Tobago*, vol. xxi, pt. iii) with the object of giving small

property and estate owners a knowledge of the disease and the methods of its control.

The origin of the disease in Trinidad is obscure. At present it is confined to two districts closely resembling one another in their physical and climatic conditions; (a) the Plum Road area (L'Ebranchi River), and (b) the Guaico-Tamana Road area (Cunapo River). The first district, where about 450 acres are infected, is low-lying and has a rainfall of 100 to 120 inches per annum. The heaviest infestation is in the portion adjacent to the river. The trees differ considerably in their susceptibility to the disease, some trees being seriously attacked, whilst neighbouring trees are scarcely affected. In the second district 130 acres are infected, mostly with a mild form of the disease. Here again the disease is most serious along the margins of streams, and, as in the Plum Road area, there are sporadic outbreaks of the disease in the neighbourhood.

Various methods of controlling the disease are recommended. The disease can only do damage to cocoa grown under conditions of high humidity, and advantage of this fact is taken in some of the indirect methods of control which are proposed. In Trinidad, it is customary to plant shade trees regularly and uniformly, irrespective of variations in rainfall, wind action, land contours, etc. It is suggested that in affected areas the number of these trees should be gradually reduced, either by poisoning them, or by employing labourers to remove them limb by limb. The adoption of annual pruning as a regular routine practice is also recommended, as it would largely reduce infection (especially if done towards the end of the drier months when new growth appears), and in addition, the pruning of the inside of the crowns of the trees would promote a more efficient ventilation and permit of a better inspection of the trees. Most of the infected areas require an improved drainage system, which would strengthen the trees and thus render them more resistant.

As, however, cocoa is the principal crop of the Colony, and as the infected area is small, it is urged that a method of direct control should be adopted. A fortnightly inspection should be made, and all the diseased material cut away, collected, and burned or buried. The surface exposed in cutting should be tarred. In the dry season, after the collection of diseased material, spraying with Bordeaux mixture or some other fungicide is stated to have proved beneficial.

**Coffee.**—T. B. McClelland (*Bull. No. 32, Porto Rico Agric. Exper. Sta., June 1928*) gives the results of some

experiments to determine the effect of topping coffee trees on the yield of coffee.

Tests were carried out beginning in December 1910. The variety used was Blue Mountain of Jamaica, which is typical of the ordinary *Coffea arabica*. The trees were set in 24 short rows of unequal length. Rows 1 and 2 were left untopped, rows 3 and 4 were topped at 6 ft. and rows 5 and 6 at 4 ft. The remaining 18 rows were treated in the same alternating sequence. The first of each of the four pairs of untopped rows received no pruning, all suckers and growth of every kind being allowed to develop freely. In the second of the untopped rows suckers were removed, so as to restrict the growth to the single original stem and developments from its laterals.

Topping forced the growth of many new uprights or suckers. These were periodically removed so as to keep the growth to the single stem and branches developing from its laterals. It was found that the picking of the crop from the topped trees was greatly facilitated, as the fruit was produced on low branches within easy reach of the pickers.

The yields of the trees were recorded over a ten-year period, 1912-21. For this period as a whole, the trees which were held to a single stem and those which were topped at 6 ft. produced only 74 per cent. as much as the unpruned trees, whilst those topped at 4 ft. produced only 58 per cent. as much. The depressing effect on production exercised by severe pruning or topping was less evident in the early years of the test than later. Thus in the three-year period 1912-14, the trees which were topped at 6 ft., and those which were held to a single trunk, produced each year within 10 per cent. of the yield of the unpruned trees. But in the seven following years, the same trees gave a yield equal to only two-thirds of that of the unpruned trees, whilst the trees topped at 4 ft. gave only half as much as the latter.

It is, therefore, considered that whilst the topping of coffee trees considerably facilitates the collection of the crop and contributes to the uniform and well-kept appearance of the plantation, these advantages do not compensate for the heavy loss of crop entailed. It is pointed out, however, that although in the tests the wholly unpruned trees gave the highest yield, the inference that no pruning is advisable should not be made. Ordinarily suckers are produced in such numbers as to make the removal of some of them very desirable.

**Tea.**—A report by M. F. Bell, entitled "Tea Planting Prospects in the South-Western Highlands of Tanganyika"

(London: Waterlow and Sons, Ltd., 1928), gives a detailed examination of the possibilities of tea-growing in that region. Climatic conditions are considered, and tables of rainfall and temperature are given for Dabaga, Mufindi and Lupembe. The soils in the area are described and their suitability for tea cultivation is discussed. It is considered that sufficient suitable native labour is available for tea-growing, but the need for settlers who will adopt a generous attitude towards the workers is strongly emphasised. The cost of transporting the tea to London would be heavy, but the situation could be greatly improved by the provision of railway facilities.

The district is healthy and suitable for European settlers. Calculations are made to indicate the capital required by a company operating on an estate of 2,000 acres, and the receipts and revenue which might be anticipated. The tea-planting prospects of private settlers are also examined, and figures are furnished regarding the capital required and the revenue to be expected by a settler with a farm of 600 acres of which 200 acres are planted with tea. It is assumed that a central factory would be provided.

It is mentioned that the Agricultural Department are making experiments in tea-growing at various points in the hills.

**Bananas.**—The "Gros Michel" or "Jamaica" banana, which is the variety extensively grown in the West Indies and the Caribbean region, is very susceptible to "Panama Disease" (*Fusarium cubense*). It is extremely desirable, therefore, to obtain a variety of banana which, whilst complying with all the requirements of the trade, shall, at the same time, be resistant to this disease. With this object in view, visits have been made by Mr. F. N. Howes, under the auspices of the Empire Marketing Board, to British Malaya, Java, Siam, Burma, South India and Ceylon, and his observations are recorded in an article in the *Bulletin of Miscellaneous Information, Royal Botanic Gardens, Kew* (1928, No. 8, p. 305).

Living material has been collected of some of the better forms of cultivated bananas (seedless), and also of the larger-fingered seeding Musas, which may possibly prove of value in the breeding of an immune variety. How far these varieties may prove resistant to the disease can only be ascertained after they have been established in the West Indies from young plants sent out from Kew.

The article contains descriptions of the many varieties of bananas encountered in the course of the work, and

photographic reproductions of several of them are provided. In each case the occurrence and habits of the plant, the size and shape of the bunches and fingers, and the flavour, colour, texture and size of the fruit, are recorded, and in many cases an estimate of the commercial value of the fruit is given.

The article concludes with some notes on the methods of cultivation employed and the diseases met with in the places visited. An index of varietal names and a useful bibliography are appended.

#### OILS AND OIL-SEEDS

**Aleurites montana.**—An experimental trial of the cultivation of *Aleurites montana* has been made at the Government Experimental Plantation, Serdang, Federated Malay States, where a small area has been planted with seed obtained originally through the Botanical and Forestry Department, Hong Kong. So far the trees have not shown vigorous growth, probably owing to unsuitable climatic conditions, this species requiring a subtropical climate (*Malayan Agric. Journ.*, 1928, **16**, 296). The trees are now approximately three years old and have yielded their first crop of seeds, a sample of which has been examined with the following results! Percentage of kernel, 52.8; moisture in kernels, 5.4 per cent.; oil in kernels, 43.2 per cent. The oil expressed from the kernels was clear and pale yellow. It gave the following constants on examination: Specific gravity at 15.5° C., 0.939; refractive index at 20° C., 1.5098; saponification value, 195.5; iodine value (Wijs), 160.3 per cent.; free fatty acids (as oleic acid), 1.8 per cent.; unsaponifiable matter, 0.6 per cent.; solidifying point of fatty acids, 36.8° C.

**Chaulmoogra Oils.**—In connection with the increased cultivation of trees yielding chaulmoogra oils, which are used in the treatment of leprosy, a survey of the present position of their cultivation in Ceylon is given in the *Tropical Agriculturist* (1928, **71**, 199). As early as 1921, *Taraktogenos Kurzii*, true chaulmoogra, was tried both at Peradeniya and at Heneratgoda, the better results being obtained at the latter place. Three varieties of *Hydnocarpus* are indigenous to Ceylon, viz. *H. venenata*, which is common up to 2,000 ft.; *H. alpina*, which occurs in the low country, particularly in the dry districts, and *H. octandra*, a somewhat rare plant, in the moist low country, particularly in the Pasdun Korale. Further supplies of seed of *T. Kurzii* were received from Burma and 100

plants have been raised and planted out at Heneratgoda. As Dr. Leonard Rogers, Hon. Medical Secretary of the British Empire Leprosy Association, has reported that the oil of *H. Wightiana* is more valuable than the oil of *T. Kurzii* in the treatment of leprosy, attention in Ceylon has been concentrated more upon the plantations of the former tree. Seed of *H. Wightiana* was received from the Royal Botanic Gardens, Calcutta, and from South India, and seed of *T. Kurzii* from the Conservator of Forests, Burma. These seeds were sown in nurseries at the Royal Botanic Gardens, Peradeniya, and the seedlings were subsequently planted out into bamboo pots until they were large enough to be put out into the field. Seed from *H. anthelmintica*, growing in the Royal Botanic Gardens, Peradeniya, has been collected and 50 plants have been put out at Heneratgoda. At the Experiment Station, Peradeniya, about three acres have been planted with 48 plants of *T. Kurzii* and 263 of *H. Wightiana*, while at the Botanic Gardens, Heneratgoda, about four acres have been planted with 80 plants of *T. Kurzii* and 128 of *H. Wightiana*. All the plants have been set 25 ft. apart in large holes and shaded with *Gliricidia maculata*. The soil between the plants has been given a good cover-crop of *Vigna* and *Centrosema pubescens*. Growth of the trees has been satisfactory, that of *Hydnocarpus* being more rapid than that of *T. Kurzii*. It is expected that fruit will be borne in from eight to ten years. It has been decided to test whether budded or grafted plants will produce fruit at an earlier date, and the necessary experiments will shortly be begun. It is interesting to note that two estates in Ceylon have also taken up the question of the cultivation of *H. Wightiana*.

**Coconuts.**—Details concerning copra crops and the cost of production in Malaya are published in the *Malayan Agricultural Journal* (1928, 16, 284). Figures have been collected annually during the seven years 1921–27, from mature areas from thirty representative estates, all of which are under European management, the total area concerned being approximately 50,000 acres. These statistics show that the average yield of copra per acre per annum was 8.73 pikuls (1 pikul = 133½ lb.), and that the production was steady from year to year, with the exception of 1926, which was an unusually good year in several districts. The average number of nuts produced per acre was 2,190 per annum, and the average number of nuts per palm was 45.6. This latter yield should be capable of considerable increase under good management,

since the best estates average about sixty nuts per tree. The average number of nuts required to produce a pikul of copra was 251. It is commonly recognised that in Malaya the nuts become smaller as the trees grow older. This is probably due to lack of cultivation, as few estates adopt any regular cultural methods. Improved cultivation, together with manuring, should substantially increase the size of the nuts and the consequent production of copra per acre, and at the same time reduce working costs. Figures are given showing the cost of production of copra in sixteen representative European-managed estates.

**Irvingia gabonensis.**—"Dika" butter is the name given to the fat prepared by natives from the seeds of *Irvingia gabonensis*. The following notes on this subject are taken from an article published in *Bull. Agence Gén. Col.* (1928, 21, 855, 922 and 1120). This tree has a wide distribution in West Africa, and occurs in the forests in the interior of Gaboon, in the Congo basin, in Dahomey and in the Ivory Coast. Two or three different varieties have been noted. After dealing with the botany of the tree, the author gives the results of the examination of the fat extracted from seeds obtained from Gaboon and the Belgian Congo. The results show the fats to be very similar in composition. They were hard, solid white fats with low iodine values and high saponification values. When freed from their slight odour, there seems to be no reason why they should not be used for edible purposes. The oil-cake from the kernels, which contain about 60 per cent. of fat, was found to consist of 31.16 per cent. of proteins, 10.0 per cent. of fat, 38.82 per cent. of carbohydrates, etc., 3.15 per cent. of crude fibre, 5.80 per cent. of ash and 11.07 per cent. of moisture. It is rich in protein and is suggested as a feeding-stuff for animals.

**Luffa Seed.**—Two samples of luffa seeds from the Belgian Congo, viz. *Luffa acutangula* and *L. cylindrica* var. *lissa*, have been found to contain respectively 48.41 and 45.72 per cent. of oil, expressed on the moisture-free kernels (*Ann. Mus. Col., Marseille*, 1928, 36, 4th Ser., vol. vi, pt. ii, p. 1). The oils are liquid at the ordinary temperature; they have a mild, agreeable taste, a brownish-green colour and belong to the class of semi-drying oils. Analytical figures are given which show the similarity of these two oils. The oil-cakes cannot be used as feeding-stuffs on account of their bitterness and probable toxicity. They are, however, rich in proteins and phosphoric acid, and could serve as fertilisers. The oil from another variety of *L. cylindrica*, viz. var. *macro-*

*carpa*, was also examined and found to yield results similar to those of var. *lissa*.

**Oil-palms.**—A review of the investigations on the oil-palm carried out at the Experiment Station at La Mé, Ivory Coast, during the year, July 1, 1925, to June 30, 1926, is contained in *Bull. Com. Études Hist. et Sci. A.O.F.* (1928, 11, Nos. 1-2, p. 144). The first section is devoted to a record of the yields of fruit from various selected palms. The formation of the oil in the process of the development of the fruits has been studied, and the results obtained have confirmed those previously indicated. At the commencement of the process of ripening, which lasts from twenty-five to thirty-four days, the pericarp is very moist and very poor in oil. During ripening loss of moisture takes place and the oil content increases rapidly. The rate of the formation of oil diminishes when the fruits have nearly reached maturity. On the other hand, the kernel has almost attained its final composition by the time the oil begins to form in the pericarp, and has completely done so by the beginning of the ripening process. In other words, the oil-palm first ripens its kernel, the reproductive part of the fruit, and then the pericarp. A method is described by means of which pollen, which is to be used in artificial pollination, may be kept in good active condition. The pollen should be removed by shaking from the male heads when a half or two-thirds of the lower anthers are fully open. It should be screened the same day to separate insects and vegetable debris, and wrapped in a thin layer in filter paper and kept in a tightly closed bottle containing anhydrous calcium chloride to keep it dry. By this means pollen may be preserved in an active state for from six to eight weeks.

The influence on the oil of fermentation of fruits before cooking has been investigated. Fruits after fermentation were cooked and pounded in a mortar and then submitted in a hydraulic press to a pressure of 100 kilos. The residue after separation of the nuts was pressed again at 150 kilos. The investigation showed that a preliminary fermentation for six to eight days increased the yield of oil by about 33 per cent. The quantity of "foots" in the crude oil was less in the case of oil expressed from fermented fruits, but the decrease was not sufficient to be of practical importance. Preliminary fermentation for five to six days did not cause excessive acidity in the oil from the first pressing or from the second pressing, provided that the latter was carried out at once, i.e. within eighteen hours of the former. A further study was under-

taken on the effect of fermentation of the fruits after being cooked. The results showed that fruits fermented after cooking gave, in comparison with fruits fermented before cooking, a reduced yield of oil, which possessed increased acidity and a fetid odour.

An account is also given of experiments with various cover crops.

Further trials with light presses for expressing the oil from the fruits have been made and have shown the advantages of these presses over the native method in respect of yield and quality of the resulting palm-oil (see this BULLETIN, 1928, 26, 363). One group of natives have purchased fifty of them.

The investigations on selection carried out at this station are described, and details are given as to the conditions for the establishment of a plantation, and also as to the clearing of the forest and the cost of forming the plantation.

## FIBRES

### *Sisal Hemp*

Reference to the cultivation of agaves in the Dutch East Indies has appeared in *Bull. Écon. de l'Indochine* (December 1928, p. 966). The plants cultivated consist of two species of agave, namely *A. sisalana* Perrine and *A. Cantala* Roxburgh. The fibre of the former plant is known as Java Sisal and that from the latter as Java Cantala. In 1918 the area devoted to the agaves in Java amounted to 9,300 hectares, whilst at the present time there are 12,100 hectares under cultivation in Java and 2,100 on the east coast of Sumatra. The total exports of the fibre have increased from 14,000 tons in 1918 to nearly 50,000 tons in 1927. The quantities (expressed in metric tons) exported from Java and Sumatra respectively during the years 1925 to 1927 are shown in the following table, which indicates that the total exports amounted

	Java.			Sumatra.		
	1925.	1926.	1927.	1925.	1926.	1927.
Holland . .	8,380	6,182	6,441	6,252	7,040	10,891
England . .	1,109	788	348	10	53	131
Germany . .	1,088	985	2,250	1,509	780	1,438
Belgium . .	384	238	1,031	128	82	114
United States . .	1,917	4,920	6,465	11,028	13,634	14,664
Australia . .	2,245	2,827	3,121	5	56	227
Other countries . .	564	535	1,364	388	195	715
Total . .	15,687	16,475	21,020	19,320	21,840	28,180

to 35,007 tons in 1925, 38,315 tons in 1926 and 49,200 tons in 1927.

The Java exports consist of fibre from both *Agave sisalana* and *A. Cantala*, whilst those from Sumatra are derived entirely from *A. sisalana*.

### *New Zealand Hemp*

Reference is made to the present position of the phormium fibre industry in New Zealand in the *Ann. Rep. Dept. Agric., New Zealand*, for 1927-28. During that year the industry was adversely affected by the fall in prices. Several companies are now engaged in growing phormium under cultivation, but it will be some years before any considerable quantity of leaves from the cultivated areas becomes available for fibre production. The services of the Government hemp-grader have been placed at the disposal of the numerous mills for purposes of instruction, and it is anticipated that this will lead to a considerable improvement in the quality of the fibre. The amount of hemp graded during the year ended March 31, 1928, was 89,130 bales as compared with 87,871 bales in the previous year; 6.56 per cent. was "good fair," 33.26 per cent. "high fair," and 45.01 per cent. "low fair."

### *Mauritius Hemp*

In the *Ann. Rep. Dept. Agric., Mauritius*, for 1927 reference is made to the inauguration of the Mauritius Hemp Syndicate, which owes its existence to an attempt to secure co-operation among growers for the provision of better grading and baling. With the aid of a Government grant, a baling and grading factory has been erected in Port Louis which is equipped with electric cranes and electrically operated hydraulic baling presses of the latest pattern. This development has led to a marked improvement in the market prices of the fibre. The factory is controlled by a Committee, comprising representatives of the leading producers of Mauritius hemp, the Government being represented by the Director of Agriculture.

### RESINS

**Shellac.**—An interesting account of the lac industry in Bengal has recently been published by R. L. Datta, D.Sc., and Tinkari Basu, B.Sc. ("The Manufacture of Shellac," *Bulletin No. 38, Department of Industries, Bengal*, 1928).

The first chapter of the bulletin deals with the raw material, crude lac, the exudation of the lac insect,

*Tachardia lacca*. The chief host trees are enumerated, and the seasons at which the lac is harvested from each are indicated. Emphasis is laid on the importance of properly drying and storing the stick lac in order to obviate deterioration. Freshly harvested "Ari" lac (lac from which the insect has not swarmed) forms hard blocks in a short time if allowed to remain in heaps, and these are an inconvenience to its later working. The authors state that the proper method of storage is to expose as much of the lac as possible to the air in a well-ventilated dry and cool place in the shade. The lac may be spread in as thin layers as space permits, and turned over as often as possible, never less than twice a day. It should be dried in this way for one month, after which it may be kept in thicker layers in a cool place.

In the second chapter, which constitutes the main portion of the bulletin, the actual manufacture of shellac from stick lac is described in detail. Apparently the existing practice is to subject the stick lac immediately to a grinding operation, and it is claimed that by means of an improved process of sifting, grinding and washing, particulars of which have already been published by one of the authors in an earlier bulletin ("Improvements in the Manufacture of Shellac," R. L. Datta, *Bulletin No. 17, Department of Industries, Bengal*, 1923), shellac of much better quality is obtained. This improved method is described in the present *Bulletin*, and its adoption by shellac manufacturers is strongly recommended, the authors stating that if this method is carried out "manufacturers will be able to turn out only the higher grades of shellac, and the bulk of their refined product will consist of 'superfines,' 'fines,' and 'standards,' with a very small percentage of the 'T.N.' quality made from the last tailings and rejections."

The stick lac on arrival at the factory is first examined to determine: (1) Kind of lac, depending on the host plant; (2) kind of crop, that is when harvested; (3) condition, whether moist or dry; (4) whether adulterated. Different kinds of lac should be treated separately, unless it is desired to obtain a particular quality to suit the market demands at the time.

The sample is then submitted to a preliminary sifting through a sieve of six meshes per inch, in order to effect an early separation of the larger particles of the stick lac, as these generally give lac of better quality than is yielded by the smaller particles, which are mixed with sand, dirt and other impurities. The lac caught on the sieve is ground to pass through a 10-mesh sieve so as to facilitate

its washing at a later stage. The other portion is freed from heavy sandy impurities by sifting through a 10-mesh sieve; the lac remaining on the sieve is then ground to pass through a 10-mesh sieve. The ground lac of this second batch, passing through the 10-mesh sieve, is sifted through a 40-mesh sieve, when the sand and dirt pass through, together with some fine particles of lac. The material caught on this 40-mesh sieve is winnowed to remove lighter particles, bits of bark, etc., and the ground lac of the first batch is also winnowed.

The material passing through the 40-mesh sieve (about 5 to 10 per cent. of the original) may be sifted through a 90-mesh sieve to remove most of the sand, etc., and the oversize recovered. The lac obtained here is of poor quality, however, since practically all the impurities present originally are concentrated in this portion before the final sifting, and it is best melted separately.

The two batches of lac prepared in the foregoing manner are next steeped in water to wash out the lac dye, dried and given a rapid winnowing to remove most of the very small quantities of twigs, bark and wood still retained.

The usual methods of melting the lac are next described.

The third chapter deals briefly with the marketing of shellac, its grades, its uses, and the costs of manufacture.

The *Bulletin* concludes with general remarks on the manner in which the shellac-making industry of India is gradually losing ground, large quantities of crude lac being exported and converted into shellac in Europe and America. This is usually carried out by the solvent process, as distinct from the more satisfactory melting process almost universally employed in India. The imposition of an export duty on unmanufactured or partly manufactured lac is suggested as a means of safeguarding the industry.

#### TANNING MATERIALS

**Tanning Barks of Madagascar.**—Reference has already been made in this BULLETIN (1928, 26, 374) to a series of articles contributed by F. Heim de Balsac and collaborators to the *Bull. de l'Agence Gén. des Colonies*, under the title "Contribution à l'Étude des Écorces Tannifères de Madagascar." A further article has recently appeared (*ibid.*, 1928, 21, 935) dealing with "Lalona" bark.

The native name "Lalona" appears to be applied in Madagascar to several different species of *Weinmannia*. The term seems to be especially used for two trees, one having a deep red, very hard wood, of excellent quality,

used for constructional purposes, cabinet-making, etc., and the other having a lighter-coloured wood of a less satisfactory nature. The authors considered that the sample of bark they examined was obtained from the former tree, *Weinmannia Bojeriana* Tul.

This sample of bark, which appeared to be derived from the trunk or the larger branches, was reddish-brown externally, 4 to 5 mm. in thickness, and fairly dense. On analysis it furnished 13·7 per cent. of tannin and 2·7 per cent. of soluble non-tannins, the ratio of these thus being as high as 5 : 1. A tanning extract prepared from the bark quickly penetrated sheep skin and produced a fairly plump, pliable, soft leather, of a rather dark brown colour. The bark could not be economically exported as a tanning material, although extracts prepared from it, being rich in tannin, might perhaps find a market. The dark colour of the extracts, however, might render them unacceptable, and it would therefore probably be necessary for them to be decolorised.

**"Neb-Neb" Pods from Senegal.**—In continuation of accounts of the French colonial tanning materials (see this BULLETIN, 1926, 24, 703 ; 1927, 25, 72 ; 1928, 26, 374), F. Heim de Balsac, in collaboration with A. Deforge and H. Heim de Balsac, has published an article, entitled "Valeur, comme Matière Tannante, des Gousses de 'Neb-Neb' du Sénégal," in the *Bull. de l'Agence Gén. des Colonies* (1928, 21, 595). The authors state that the native name "Neb-Neb" is applied indiscriminately to different varieties of *Acacia*, viz. *Acacia arabica* Willd., the type to which the vernacular name "Gonakié" is generally given, and *A. arabica* var. *Adansoniana* Dubard (= *A. Adansonii* Guill. and Perr.). It is best, however, to restrict the name to the latter type.

The "Neb-Neb" tree differs from "Gonakié" in having a rounded top, and its bark, branches and thorns are grayer in colour, the first being also more deeply furrowed. The fruits are thicker than those of "Gonakié," and are not constricted but merely have an undulating surface.

"Neb-Neb" grows on the rising ground above the flooded areas to the south of the Senegal River, whereas "Gonakié" forms the greater part of the *Acacia* areas occurring along the banks of the same river on ground covered more or less copiously with water.

"Neb-Neb" is found associated with "Sing" (*Acacia Sing* Guill. and Perr.), "Verek" (*A. Vereh* Guill. and Perr.), "Sourona" (*A. Seyal* Delile) and "Soump" (*Balanites*

*ægyptiaca* Delile). All parts of "Neb-Neb" contain tannin except the wood. The roots, 3 to 10 mm. in diameter, have a bark which furnishes 35 per cent. of tannin; the old trunk bark, 5 mm. in thickness, contains 13 per cent. in the outer layer and 25 per cent. in the inner, whilst the branch bark, 2 mm. in thickness, contains 29 per cent.

The "Neb-Neb" pods examined by the authors had an average weight of about 0.2 gram per pod, and consisted of 72 per cent. of pod case and 28 per cent. of seed. On analysis the entire pods yielded 24.1 per cent. of tannin and 18.0 per cent. of soluble non-tannins, whilst the pods freed from seeds furnished 36.8 per cent. of tannin and 18 per cent. of soluble non-tannins.

For purposes of comparison the authors quote figures given by Yves Henry and P. Ammann, who obtained 40.8 per cent. of tannin from entire half-grown pods, and 21.4 per cent. from fully ripe pods.

The "Neb-Neb" pods resembled the "Gonakié" pods in composition, but perhaps contained somewhat less tannin.

A tannin extract prepared from "Neb-Neb" pods quickly penetrated sheep skin, and produced a soft, pliable leather of very satisfactory appearance.

In conclusion the authors point out the similarity between "Gonakié" and "Neb-Neb" pods from the tanning point of view, and state that the tannin content depends more on the degree of ripeness of the pods than on their botanical origin.

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Les Acajous. By M. Monnin. *Actes et Comptes-Rendus de l'Association Colonies-Sciences* (1928, 4, 209-215).

Windbreaks. By F. S. Danks. *Agricultural Supplement No. 5 to the Cyprus Gazette* No. 1954 of November 30, 1928, pp. 1-2.

Het Gebruik van Vliegtuigen voor Boschbouwkundige Doeleinden. By L. Verhoef. *Tectona* (1928, 21, 841-878).

Herbosschingswerk in Bagelen, 1875-1925. By W. G. J. Zwart. *Med. Proefsta. voor Boschwezen*, No. 17, *Dept. van Landb., Ned.-Ind.* Pp. 234 + 6 plates and map, 9½ × 6½. (Weltevreden: Landsdrukkerij, 1928.)

Geslachtstabellen voor Ned.-Indische Boomsoorten naar vegetatieve kenmerken met een beschouwing over de practische en systematische waarde dezer kenmerken. By F. H. Endert. *Med. Proefsta. voor Boschwezen*, No. 20, *Dept. van Landb., Ned.-Ind.* Pp. 242, 9½ × 6½. (Wageningen: H. Veenan en Zonen, 1928.)

Stamtal en dunning een oriënteerend onderzoek naar de beste plantwijdte en dunningswijze voor den djate. By H. M. J. Hart. *Med. Proefsta. voor Boschwezen*, No. 21, *Dept. van Landb., Ned.-Ind.* Pp. 219 + Platenatlas of 69 figures, 9½ × 6½. (Wageningen: H. Veenan en Zonen, 1928.)

The Sirex Wood-wasps and their Importance in Forestry. By R. N. Chrystal. *Bull. Entom. Res.* (1928, 19, 219-247).

Studies in Forest Pathology. 1. Decay in Balsam Fir (*Abies balsamea* Mill.). By A. W. McCallum. *Bull. No. 104, New Series, Dept. Agric., Canada.* Pp. 25, 9½ × 6½. (Ottawa: King's Printer, 1928.)

### Timbers

Bibliography on Woods of the World. By G. P. Ahern and H. K. Newton. *Scientific Contributions, No. 10, Tropical Plant Research Foundation Series, Washington.* Pp. 77, 10 × 7. (Washington, D.C.: Tropical Plant Research Foundation, 1928.)

The British Lumber Market. By A. E. Boadle. *Trade Promotion Series, No. 64, U.S. Dept. Com.* Pp. 352, 9 × 6. (Washington, D.C.: Government Printing Office, 1928.) Price 60 cents.

Indian Tariff Board. Match Industry. Vol. I. The Written and Oral Evidence given by the Indian Match Manufacturers in Bengal,

Bihar and Orissa, Burma, Central Provinces, Madras, Punjab, United Provinces. Pp. 651,  $9\frac{1}{2} \times 6\frac{1}{2}$ . (Calcutta: Government of India Central Publication Branch, 1928.) Price Rs. 1.12 or 3s.

Les Bois de la Guyane Française dans l'Industrie de la Tonnellerie. By M. Demongeot. *Bull. de l'Ag. Gén. des Col.* (1928, 21, 1221-1231).

L'Utilisation de l'Angélique de la Guyane dans l'Industrie Tonnelière. By J. Meniand. *Agron. Col.* (1928, 17, No. 131, 129-132).

Queensland Timbers for Fishing-rods. By C. J. J. Watson. *Queensland Agric. Journ.* (1928, 30, 477-480).

Catalogue of a Private Collection of Walking Sticks. By Rudolph Block. Pp. 149,  $8\frac{1}{2} \times 5\frac{1}{2}$ . (New York: The Author, 1928.)

*Lyctus* Powder-Post Beetles. *Bull. No. 2, Forest Prod. Res., Dept. Sci. and Ind. Res.* Pp. 46,  $9\frac{1}{2} \times 7\frac{1}{2}$ . (London: H.M. Stationery Office, 1929.) Price 3s.

Insektenbeschädigungen an überseeischen Hölzern. By H. Strohmeier. *Tropenpflanzer* (1929, 32, 36-38).

#### Gums and Resins

The Manufacture of Shellac. By R. L. Datta and Tinkari Basu. *Bull. No. 38, Dept. of Indust., Bengal.* Pp. 32,  $9\frac{3}{4} \times 6\frac{1}{2}$ . (Calcutta: Bengal Secretariat Book Depot, 1928.) Price 14 annas or 1s. 6d.

Physical Properties of Shellac Solutions. Part I. By M. Rangaswami and M. Venugopalan. *Bull. No. 1, Indian Lac Association for Research.* Pp. 14,  $9\frac{3}{4} \times 7\frac{1}{2}$ . (Calcutta: Indian Lac Association, 1928.)

#### Tanning Materials

Divi-Divi, *Caesalpinia Coriaria*. By K. Seshachalam Choudary. *Bull. No. 26, Dept. of Indust., Madras.* Pp. 20,  $9\frac{3}{4} \times 6$ . (Madras: Superintendent, Government Press, 1928.) Price 6 annas.

Wattle Bark, Its Use and Cultivation in South India. By K. Seshachalam Choudary. *Bull. No. 3, Leather Trades Institute, Dept. of Indust., Madras.* Pp. 28,  $9\frac{3}{4} \times 6$ . (Madras: Superintendent, Government Press, 1927.) Price 1½ annas.

Bulletin of the Wattle and Timber Growers' Association, October 1928. Pp. 6,  $9\frac{1}{2} \times 6$ . (Pietermaritzburg, Natal: Wattle and Timber Growers' Association, 1928.)

Manuring of Wattles. By C. O. Williams. *Farming in S. Africa* (1928, 3, 1013-1014).

Contribution à l'Étude des Écorces Tannifères de Madagascar. VI. Écorce de "Lalona." By F. Heim de Balsac, A. Deforge, J. Maheu and H. Heim de Balsac. *Bull. de l'Ag. Gén. des Col.* (1928, 21, 935-945).

Contribution à l'Étude des Écorces Tannifères de Madagascar. VII. Écorce de "Fany" (*Piptadenia chrysostachys*). By F. Heim de Balsac, A. Deforge, J. Maheu and H. Heim de Balsac. *Bull. de l'Ag. Gén. des Col.* (1928, 21, 1266-1274).

Valeur, comme Matière Tannante, des Gousses de "Neb-neb" du Sénégal. By F. Heim de Balsac, A. Deforge and H. Heim de Balsac. *Bull. de l'Ag. Gén. des Col.* (1928, 21, 595-603).

Contribution à l'Étude des Écorces Tannifères de la Guyane Française. By F. Heim de Balsac, A. Deforge and H. Heim de Balsac. *Bull. de l'Ag. Gén. des Col.* (1929, 22, 36-48; cont.).

## NOTICES OF RECENT LITERATURE

EASTERN AFRICA TO-DAY. Compiled and Edited by F. S. Joelson. Pp. xvi + 420, 10 × 6½. (London: "East Africa," 1928.) Price 5s.

This volume furnishes a brief description of British Somaliland, Kenya, Tanganyika, Zanzibar, Uganda, Nyasaland and Northern Rhodesia, and particulars are also included regarding the Sudan and Portuguese East Africa. The publication is well printed and illustrated, and can be recommended as a concise book of reference for the territories with which it deals. It should be specially interesting to those intending to visit Eastern Africa for purposes of trading or settlement.

A COMMERCIAL HANDBOOK OF THE NETHERLANDS EAST INDIES. By Philip C. Coote. Third Edition, 1928. Pp. 91, 8½ × 5½. (London: Sampson Low, Marston & Co. Ltd.) Price 3s.

This well-arranged publication should be of considerable utility to those engaged in trade with the Netherlands East Indies. According to Mr. Coote, there is a very extensive market for British goods in the countries concerned, and traders who have taken the trouble to comply with local requirements have, as a rule, had no cause for dissatisfaction. The Handbook furnishes information on the commodities chiefly in demand, local industries, agricultural and mineral products, administration, taxation and import duties, finance, communications, shipping, and other matters of interest. A few misprints, such as *logostemon* for *Pogostemon* (p. 43) and *Anglo-British* for *Anglo-Dutch* (p. 79), might be corrected in a future edition.

EMPIRE AND COMMONWEALTH. STUDIES IN GOVERNANCE AND SELF-GOVERNMENT IN CANADA. By Chester Martin. Pp. xxi + 385, 8½ × 5½. (Oxford: The Clarendon Press, 1929.) Price 21s.

The author, who is head of the Department of History at the University of Manitoba, has in this volume furnished a useful contribution to the literature of Canadian history. The book is divided into six sections, of which, in the words of the introductory chapter, "the first three relate to the first Empire and the disaster which overtook it at the American Revolution; the last three to the truly British solution of 'the American question' in the practice of responsible Government."

It is pointed out that Canadian history is highly complex, and that for a variety of reasons a comprehensive history of the Dominion may long remain a counsel of perfection. The present volume should, however, prove a valuable addition to historical libraries, and very helpful to those interested in the political development of the British Empire.

DER KAPOK IN DER WELTWIRTSCHAFT. By Dr. Walter Grunow. Pp. 129, 8 × 6. (Berlin: Wilhelm Christians Verlag, 1928.) Price Rm. 6.

This useful little work gives an excellent account of the production and utilisation of the vegetable floss known as kapok. After referring to the true kapok tree (*Eriodendron anfractuosum*) and a number of other plants yielding similar fibres, the author describes the fibre itself, its characteristics and uses, its position among other flosses, and its consumption in different countries. Other matters discussed include the geographical distribution of the kapok or silk-cotton yielding plants, the conditions required for their growth, the methods of cultivating them, the collection of the fruits and the preparation of the fibre, the development of kapok production in the Dutch East Indies and other countries, and the organisation of the market. Information is also provided on the international extension of the kapok trade and the prices of the material. A bibliography is appended.

In view of the questions raised during the Board of Trade enquiry into the life-boat disaster at Rye regarding the value of kapok for use in life-saving appliances, certain statements made in this book are of special interest. For example, it is stated (p. 15) that, owing to their low specific gravity, the thin-walled, air-filled fibres have considerable buoyancy, which is three times as great as that of reindeer hair and five times as great as that of cork. Kapok can support twenty-five to thirty times its own weight in water, reindeer hair only eleven times, and cork only six times its weight. Again, on p. 20 the author remarks that, in respect of buoyancy, kapok surpasses all competing substances, particularly cork, sunflower pith and reindeer hair. Its chief rival is cork, of which, as already stated, the weight-carrying capacity in water is only one-fifth of that of kapok. Kapok is also markedly superior to its competitors in durability. Whereas in the case of reindeer hair and cork the buoyancy rapidly deteriorates, kapok suffers a loss of only 10 per cent. of its buoyancy after being in water for thirty days. Another advantage of kapok is that after drying it fully regains its original supporting power.

LA GOMME DE BALATA. By A.-D. Luttringer. Pp. 50, 9 × 5½. (Paris : A.-D. Cillard, 1929.)

This little work has just appeared in the series of publications entitled "Encyclopédie du Caoutchouc et des Matières Plastiques." It gives a general account of balata, including its source, physical characters and chemical composition. The properties of the latex are described and information is supplied on the methods of collection and coagulation, and on the preparation of the balata for the market. An account is given of the balata industry in the Valley of the Orinoco, in British Guiana, and in Surinam, Brazil and Peru. The purification of the material and its properties and uses are discussed, and particulars are furnished regarding its recovery from waste, its analysis, its estimation in admixture with rubber, its prices, and the world's production. The book has been carefully compiled and will serve a useful purpose.

LES PARFUMS. By R. Le Florentin. Second Edition. Pp. xiv + 264, 7½ × 4½. (Paris : Desforges, Girardot & Cie., 1927.)

This little book, issued in the *Nouvelle Collection de Recueils de Recettes Rationnelles*, opens with a brief account of the usual methods employed in the extraction of essential oils from plants, and the preparation of aqueous and alcoholic perfume extracts. Data are supplied with regard of the comparative volatility, antiseptic values and the initial boiling-points of some common essential oils. Short descriptions are given of natural and synthetic perfume materials and other substances used in perfumery, arranged in alphabetical order. General methods for the compounding of perfume materials are dealt with briefly in a short chapter containing illustrations of machines for grinding, filtering, mixing and conditioning. As the title of the series indicates, the greater part of the book is devoted to recipes, of which there are 679, for the preparation of various classes of perfumes and perfumed substances, including cosmetics, disinfectants, soaps and dentifrices. The information given, although concise, covers a wide field. Indeed, no class of manufactured material in which perfumes play any part appears to have been omitted.

STARCH : ITS CHEMISTRY, TECHNOLOGY AND USES. By Lewis Eynon, B.Sc., F.I.C., and J. Henry Lane, B.Sc., F.I.C. Pp. viii × 256, 8½ × 5½. (Cambridge : W. Heffer & Sons, Ltd., 1928.) Price 12s. 6d.

In recent years our knowledge of the properties and constitution of starch has been enormously extended.

Much attention has also been given to improvement in the technology and the manufacture of starch and starch products. No textbook, however, has been published in English embodying both aspects of this subject and it has been the authors' aim to meet this need.

. After a short introductory chapter on the history of starch, there follow three chapters, comprising about a quarter of the whole volume, which deal with its constitution and properties. In this section the writers have contented themselves with collecting together the available information without attempting its co-ordination. An interesting chapter on the microscopy of starch contains some excellent illustrations. The remainder of the book, with the exception of the last chapter which deals with analysis, discusses the manufacturing and commercial aspects of the subject. Comprehensive accounts of the preparation of starches are given, and numerous references are supplied to the sources of information.

THE PROBLEM OF FERMENTATION: THE FACTS AND HYPOTHESIS. By M. Schoen, translated from the French by H. Lloyd Hind, B.Sc., F.I.C., and revised and enlarged by the author. Pp xii + 211,  $9\frac{3}{4} \times 6$ . (London: Chapman & Hall, Ltd., 1928.) Price 21s.

This book does not aim at being a textbook on fermentation but rather an exposition of ideas arising out of a study of the present known facts.

The author devotes his attention principally to the study of alcoholic fermentation, the secondary actions accompanying it and the resulting accessory products. The importance of the reaction of the medium is discussed, and the monograph concludes with chapters on hydrogen ion concentration and the relationship between hydrogen and the phenomena of fermentation.

Facts and theories are presented in a lucid and interesting manner, and those who wish to study the problems of fermentation more fully will find the bibliographical index of much assistance.

YEAR BOOK OF AGRICULTURAL CO-OPERATION IN THE BRITISH EMPIRE, 1929. Edited by the Horace Plunkett Foundation. Pp. 476,  $8\frac{1}{4} \times 5\frac{3}{4}$ . (London: George Routledge & Sons, Ltd., 1929.) Price 10s. 6d.

The articles published in this volume cover a wide field, and should be of considerable interest to students of agricultural economics. The principal article, which occupies over fifty pages and is entitled "A Report on Agricultural Business in Ceylon, Australia, Tasmania, New Zealand

and Canada," is written by Mr. Karl Walter, Secretary of the Horace Plunkett Foundation, and is the outcome of a tour through the countries mentioned. A section of the book deals briefly with the last two years' co-operative legislation throughout the world ; this is followed by short notices on co-operative literature, whilst the last part of the volume is occupied by a Statistical Census of Agricultural Co-operative Organisations in the British Empire.

CATTLE MANAGEMENT : A TEXTBOOK FOR THE USE OF NATIVE SCHOOLS IN AFRICA. By J. R. Fell and R. A. S. Macdonald, B.Sc., M.R.C.V.S. Pp. 83,  $7\frac{1}{4} \times 4\frac{3}{4}$ . POULTRY HUSBANDRY : A TEXTBOOK FOR THE USE OF NATIVE SCHOOLS IN AFRICA. By J. R. Fell. Pp. vi + 66,  $7\frac{1}{4} \times 4\frac{3}{4}$ . (London : Christian Literature Society for India and Africa, 1928.) Price 1s. each.

These two small handbooks are of the same general character as Mr. Fell's *Field Crops of Central Africa* previously noticed in this BULLETIN (1926, 24, 719). Though intended mainly for use in African schools, they should also be of practical value to many working farmers and others concerned with the industries dealt with. The subjects are presented in a clear, concise and informative manner, useful illustrations are supplied, and the printing and general style of the publications are on a high level of excellence.

THE FOREST INDUSTRY OF FINLAND. By W. E. Hiley, M.A. Oxford Forestry Memoirs, Number 8, 1928. Pp. 39,  $11 \times 7\frac{1}{2}$ . (Oxford : The Clarendon Press, 1928.) Price 4s. 6d.

This monograph is a valuable addition to the literature dealing with the timber industry of Finland. Outside the trade the importance of Finland as a timber-producing country is not generally known. Finland has an area of 150,000 square miles (70 per cent. greater than that of Great Britain) and exports more timber than any other country in Europe, the United Kingdom being by far her best customer. The forests are nearly continuous, being broken only occasionally by areas of cultivation. The soil is sandy in nearly all districts and gives rise to a ground flora of which the predominant species are *Vaccinium Myrtillus*, *V. Vitis-idaea*, *Calluna vulgaris* and *Ledum palustre*. The tree species are comparatively few, Scots pine, Norway spruce (*Picea excelsa*), white birch (*Betula verrucosa* and *B. pubescens*) being the only trees of considerable commercial account. Aspen (*Populus tremula*)

is found in small quantities in the south and grey alder (*Alnus incana*) is found as a scrubby growth.

In Southern Finland, the forests are characteristically even-aged and nearly all comprise the tree species mentioned. In the north, the same species occur but they tend to segregate and form poor forests, but pine forests are met with pure on poor sandy soils. On heavier soils birch and spruce form pure stands.

The total area of forest land both of productive and of poor timber growth comprises 25.26 million hectares, containing an estimated volume of standing timber of 57,700 million cubic feet of which, it is estimated, 48 per cent. is pine, 29.6 per cent. spruce and 19.7 per cent. birch, with aspen and grey alder 1.4 per cent. and 1.3 per cent. respectively.

Half the area is in private hands and 40 per cent. is state-owned, the remainder being in possession of joint stock companies, ecclesiastical authorities and communities. Commercial depletion of the forests has caused some anxiety in regard to the maintenance of supplies, but silviculture has developed under the leadership of Professor Cajander and regeneration is now proceeding. Very ready seed germination and freedom from damage by wind permit of a simple procedure in regard to regeneration, by which a few scattered mother trees are left standing for seeding until regeneration is completed. This method is particularly successful on the drier soils, but in moist lands the competition of weeds renders the system difficult. Here direct seeding is practised either by broadcasting on the snow or by ploughing in after removal of the top sod; it is seldom necessary to plant pine.

The planting of exotics has been introduced, and *Larix sibirica*, *L. kurilensis* and *Pinus Murrayana* so far have given very good results; other encouraging species are *Pseudotsuga Douglasii* var. *cæsia* and *Thuja plicata*.

The author discusses these and relative topics in eleven sections of a very interesting book, which is illustrated with good photographs.

FOUNDATIONS OF SILVICULTURE UPON AN ECOLOGICAL BASIS. By James W. Toumey, M.A., F.D., Sc.D. Volume I. Pp. xxv + 438, 9 × 5½. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1928.) Price 20s.

The "foundations of silviculture" as discussed in this work are in effect the application of the principles of plant ecology to forestry operations, though the author feels disposed to regard ecology as an outgrowth of silviculture, for he points out that, when biologists transferred

their researches into the relation of plants to environment from the laboratory into the field, they found foresters already in possession of a century's experience on the phenomena under investigation. He remarks that, from the beginning of silvicultural practice, foresters had been cognisant of effects produced by variations in soil and climate upon the type of forest vegetation encountered, but it would seem that for a long period the principle underlying the mass of accumulated observations was not fully recognised by the observers. The author states this principle in the following terms: "Forest vegetation is composed of plant communities or units of vegetation, developed and arranged in accordance with definite biological laws, and is not an aggregation of trees and other plants brought together by chance." This is, indeed, the text upon which the book has been written, and the application of the principle is in regard to the forests of the United States. The author recognises the limitations imposed upon one who attempts to give an exposition of the ecology of the forest vegetation of so large an area as the United States, but it would seem that he has carefully surveyed available information and provided a very useful discussion of the subject. The manual of which this book is the first volume is divided into three main sections, namely, Site Factors (Part I), Forest Vegetation (Part II) and Methods of Investigating the Site Factors and Forest Vegetation (Part III); the first two sections only are contained in this book. In dealing with site factors, the various external agents which act upon forest vegetation and the modifications due to them are considered, as well as the reactions of the forest vegetation to these factors. Part II, concerned with forest vegetation, presents an analysis of the forest, the units of forest vegetation, their origin and development under the action of the site factors and the biology of the stand of trees and of the individual. As is inevitable from the nature and scope of the subject, the book offers a great deal of close reading and is somewhat exceptional (though not necessarily at a disadvantage) in having few illustrations.

THE MOTOR MECHANISM OF PLANTS. By Sir Jagadis Chunder Bose, M.A., D.Sc., LL.D., F.R.S., C.S.I., C.I.E. Pp. xxv + 429, 8 $\frac{1}{2}$  × 5 $\frac{3}{4}$ . (London: Longmans, Green & Co., 1928.) Price 21s.

The author's well-known researches on the irritability of plant tissues have afforded him material for another addition to the list of volumes which he has published in explanation of his work and experimental methods. The

present book, which contains some thirty chapters, is concerned more especially with an investigation of the motor mechanism of the plant as compared and contrasted with that of the animal. The author's work in this direction dates from 1901, and the account now available gives all the important results obtained on the "motor response of plants, including single and multiple response as well as automatic movement," and also deals with their functional significance in the life of the plants. It is well known that the author has given considerable attention to the question of the mechanism of the ascent of sap and in this new volume he takes the opportunity of furnishing a more detailed account of the "rhythmic peristaltic activity" which he regards as the agent by which sap is propelled in the plant. From its commencement the work of Sir Jagadis Bose has aroused much interest among botanists and others, and the researches described in the present volume are not likely to be considered the least striking in the now lengthy series.

**COLLOID CHEMISTRY: THEORETICAL AND APPLIED.** By selected international contributors. Collected and edited by Jerome Alexander. Volume II. Biology and Medicine. Pp. 1029, 9 × 6. (New York: The Chemical Catalog Company, Inc., 1928.) Price \$15.50.

**COLLOID SYMPOSIUM MONOGRAPH.** Papers presented at the Fifth Symposium on Colloid Chemistry, University of Michigan, June 1927. Edited by Professor Harry Boyer Weiser. Pp. 394, 9 × 6. (New York: The Chemical Catalog Company, Inc., 1927.) Price \$6.50.

**COLLOID SYMPOSIUM MONOGRAPH.** Papers presented at the Sixth Symposium on Colloid Chemistry, University of Toronto, June 1928. Edited by Professor Harry Boyer Weiser. Pp. 346, 9 × 6. (New York: The Chemical Catalog Company, Inc., 1928.) Price \$6.50.

The first of these publications is the second volume of a work of which the first volume has been reviewed in this BULLETIN (1926, 24, 524), and like the latter consists of a collection of separate papers, each of which is complete in itself. Although the subjects are limited to matters concerning colloid chemistry in its relation to biology and medicine, the range covered is extremely wide. The editor observes in his preface that "the field is sufficiently well covered to give the reader an idea of the ubiquity of colloid phenomena which, while not the sole factors in life, nevertheless enter to a greater or less extent into every manifestation of life."

The two Colloid Symposium Monographs also consist of collections of papers dealing with very diverse aspects of the study of colloids, and, like the above work, can be recommended to readers wishing to keep themselves informed of progress in the subject. It may be mentioned that the guest of honour at the University of Michigan on the occasion of the Fifth Symposium was Professor H. R. Kruyt of the University of Utrecht, who presented a paper on "Unity in the Theory of Colloids"; at the Sixth Symposium at Toronto the same position was occupied by a well-known English physiologist, Sir William B. Hardy, who gave an interesting address on "Living Matter."

DIZIONARIO DI MERCEOLOGIA E DI CHIMICA APPLICATA. By Professor Dr. G. Vittorio Villavecchia in collaboration with Professors Dr. G. Fabris, Dr. G. Rossi and Dr. R. Belasio. Fifth Edition. Volume I (Abelmosco-Cuscuta). Pp. xvi + 612, 10 × 7. (Milan: Ulrico Hoepli, 1929.) Price L.60.

A notice of the fourth edition of this very useful work appeared some years ago in this BULLETIN (1923, 21, 562). As there indicated, the Dictionary deals with the raw materials and manufactures of the chemical, pharmaceutical, metallurgical, agricultural and other industries, and covers a very wide range of products. The scope of the work will be gathered from the fact that the present volume, although only comprising letters A to C, consists of over 600 pages. The commercial and technical names of products are given not only in Italian, but in French, English, German and Spanish, and chemical formulæ and systematic botanical and zoological names are plentifully supplied.

In a prefatory note to the volume it is pointed out that the fourth edition of the Dictionary was issued shortly after the war and suffered from the uncertainty and scarcity of the information then available in certain directions, but that in the present edition it has been possible to give an adequate, if necessarily concise, account of the numerous subjects dealt with. The work can be strongly recommended as an encyclopædia of the products met with in commerce and industry.

DIAMOND: A DESCRIPTIVE TREATISE. By J. R. Sutton, M.A., Sc.D. Pp. xii + 118, 8½ × 5½. (London: Thomas Murby & Co.; New York: D. Van Nostrand Company, 1928.) Price 15s.

"There is a mountain of literature dealing with diamond though the effective portion of it is a very small

mouse. Moreover, the amount of misstatement even on matters of simple observation is extraordinary." The above extract from the preface of the volume under notice gives some indication of the author's distrust of existing literature relating to diamond. He has had exceptional facilities for becoming familiar with diamond in its raw condition, having been for thirty-five years closely connected with the industry in the Kimberley district, and the book he has produced is compiled almost wholly from his own observations during that period, there being very few references to the works of other writers.

The subject-matter is chiefly concerned with the nature, form and mode of occurrence of the diamond, and is handled in a very practical way. There are also interesting chapters on local characteristics, the genesis of diamond, the law of diamond values and other matters.

The treatise is very well illustrated with line drawings and photo-micrographs. It is written in a popular style, so that it should appeal to the ordinary reader almost as much as to the specialist, and can be recommended as a good and very practical descriptive account of the diamond.

HANDCRAFT POTTERY FOR WORKSHOP AND SCHOOL.  
By Henry and Denise Wren. Pp. xii + 162,  $9\frac{1}{4} \times 6\frac{1}{4}$ .  
(London : Sir Isaac Pitman & Sons, Ltd., 1928.) Price 12s. 6d.

Those who have experimented with the making of pottery, on however small a scale, must have experienced the strange fascination attached to this pursuit, and must, in many instances, have wished for explicit directions regarding the best manner in which to carry out the different operations. Those who have access to the various centres in which pottery is taught have, of course, no need for printed instructions, but there are many who have no such facilities. To these, this book will prove most useful, as it gives clear directions, accompanied by photographs and sketches, for the procedure to be adopted in the making, glazing and firing of vessels of various kinds.

The actual compounding of the bodies and glazes is not discussed, these operations being regarded as of too technical a nature to be successfully undertaken by the average amateur.

The chapters dealing with kilns and firing would be improved by the incorporation of a few dimensioned diagrams, as those unfamiliar with furnace construction would probably find it difficult to build a working kiln solely from the data given.

There appears to be a tendency in some quarters to decry the work of the amateur potter. It may not always have the finish of the products of Stoke-on-Trent or Lambeth, but it often possesses individuality and distinction. All things must have a beginning, and by perseverance and industry, aided by expert guidance, the amateur may achieve results of permanent value. This book may therefore be thoroughly recommended to those amateurs wishing to learn the rudiments of pottery handcraft or to improve their present technique.

THE PRINCIPLES OF UNDERDRAINAGE. By Reginald David Walker, M.C., A.R.C. Sc., D.I.C., Assoc.M.Inst.C.E. Pp. xxiv + 223,  $8\frac{1}{2} \times 5\frac{1}{2}$ . (London : Chapman & Hall, Ltd., 1929.) Price 15s.

The lack of special treatises dealing with the subject of this volume makes its appearance welcome ; it should prove valuable to all civil, railway and mining engineers who have to deal with drainage problems, especially in the wetter parts of the tropics. The author has qualified himself for his task by gaining a valuable practical experience in a country which provides every variety of drainage problem.

The book begins with a chapter of definitions of terms employed later on and then describes the general conditions under which underground waters occur ; it then proceeds with a description of different methods of underdrainage, including the necessary survey work.

Special chapters then follow on the underdrainage of ravines, flat lands and railway and other cuttings for the prevention of slips and subsidences ; while the drainage of land for the controlling of mosquitoes is also considered. Further information is supplied on cost estimation, pipe work, flow of water in pipes, maintenance and contract specifications. One chapter on open drains deals with storm waters. The book is excellently illustrated with original diagrams, etc., and concludes with some useful appendices and an index.

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#### BOOKS RECEIVED FOR NOTICE

BRITISH COLONIAL POLICY AND THE SOUTH AFRICAN REPUBLICS, 1848-1872. By C. W. de Kiewiet, M.A., Ph.D. Pp. xiii + 317,  $8\frac{3}{4} \times 5\frac{1}{2}$ . (London : Longmans, Green & Co., Ltd., 1929.) Price 12s. 6d.

FRUIT-GROWING IN SOUTH AFRICA. By R. A. Davis. Pp. 532,  $8\frac{1}{2} \times 5\frac{1}{2}$ . (South Africa : Central News Agency, Ltd., 1928.) Price 27s. 6d.

ALFALFA. By J. F. Cox and C. R. Megee. Pp. xi + 101,  $8 \times 5\frac{1}{4}$ . (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1928.) Price 7s. 6d.

THE PREPARATION OF PLANTATION RUBBER. By Sidney Morgan, A.R.C.S., with a preface and chapter on vulcanisation by Henry P. Stevens, M.A., Ph.D., F.I.C. Second Edition. Pp. xvi + 357,  $8\frac{3}{4} \times 5\frac{3}{4}$ . (London: A. Constable & Co., Ltd., 1928.) Price 21s.

ARTIFICIAL SILK. By Dr. O. Faust, translated from the German by Ernest Fyleman, B.Sc., Ph.D., F.I.C. Pp. vii + 184,  $8\frac{1}{2} \times 5\frac{1}{2}$ . (London: Sir Isaac Pitman & Sons, Ltd., 1929.) Price 10s. 6d.

SUCCESS ON IRRIGATION PROJECTS. By John A. Widtsoe, Ph.D., LL.D. Pp. v + 153,  $8 \times 5\frac{1}{4}$ . (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1928.) Price 8s. 6d.

AN ECONOMIC AND FINANCIAL ANALYSIS OF FIVE EASTERN COUNTIES FARMS IN 1927-28. By R. Mc G. Carslaw, M.A., and W. H. Kirkpatrick, C.D.A. University of Cambridge, Department of Agriculture, Farm Economics Branch Report No. 11. Pp. 13,  $9 \times 7\frac{1}{2}$ . (Cambridge: W. Heffer & Sons, Ltd., 1928.) Price 1s.

PRACTICAL COOPERATIVE MARKETING. By A. W. McKay, B.S., and C. H. Lane, M.A., Ph.D. Pp. xvii + 512,  $8 \times 5\frac{1}{4}$ . (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1928.) Price 15s.

FLOWERING PLANTS OF THE NORTHERN AND CENTRAL SUDAN. By Grace M. Crowfoot, with an introduction by A. F. Broun. Pp. 25 + 174 illustrations. (London: Wheldon & Wesley, Ltd.) Price 7s. 6d.

THE CHEMISTRY OF LEATHER MANUFACTURE. Volume I. Second Edition. By John Arthur Wilson. Pp. 495,  $9 \times 6$ . (New York: The Chemical Catalog Company, Inc., 1928.) Price \$10.00.

THE EVOLUTION AND CLASSIFICATION OF SOILS. By Dr. E. Ramann, translated by C. L. Whittles, M.A., Ph.D. Pp. xii + 127,  $8\frac{1}{2} \times 5\frac{1}{4}$ . (Cambridge: W. Heffer & Sons, Ltd., 1928.) Price 7s. 6d.

AGRICULTURAL ENTOMOLOGY. By D. H. Robinson, B.Sc., and S. G. Jary, B.A. Pp. xi + 314,  $7\frac{3}{4} \times 5$ . (London: Gerald Duckworth & Co., Ltd., 1929.) Price 15s.

THE SCIENTIFIC PRINCIPLES OF PLANT PROTECTION. By Hubert Martin, M.Sc., A.R.C.Sc., A.I.C., with a foreword by Sir Daniel Hall, K.C.B., F.R.S. Pp. xii + 316,  $8\frac{1}{2} \times 5\frac{1}{2}$ . (London: Edward Arnold & Co., 1928.) Price 21s.

ENGINEERING FOR FOREST RANGERS IN TROPICAL COUNTRIES, with special reference to Burma. By A. H. Lloyd, M.C., M.A. Pp. xvi + 228,  $9\frac{1}{2} \times 6\frac{1}{2}$ . (Oxford: The Clarendon Press, 1929.) Price 17s. 6d.

THE THEORY OF THE GENE. By Professor Thomas Hunt Morgan. Pp. xviii + 358,  $9 \times 6$ . Enlarged and revised edition. (New Haven: Yale University Press, 1928.) Price \$4.00.

AN INTRODUCTION TO THE STUDY OF ORE DEPOSITS. By F. H. Hatch, O.B.E., Ph.D. Pp. 117,  $8\frac{1}{2} \times 5\frac{1}{2}$ . (London: George Allen & Unwin, Ltd., 1929.) Price 7s. 6d.

LOW-TEMPERATURE CARBONIZATION (OR DISTILLATION) EXPLAINED. By Murray Stuart, D.Sc., Ph.D., F.G.S., F.C.S., M.Inst.P.T., Assoc.M.I.Min.E. Pp. 56,  $8\frac{3}{4} \times 5\frac{1}{2}$ . (London: Mining Publications, 1929.) Price 4s.

PATTERNS FOR THE CONSTRUCTION OF CRYSTAL MODELS REPRESENTING ACTUAL MINERALS. Designed and drawn by Frank Smithson, Ph.D., F.G.S. (London: Thomas Murby & Co.; New York: D. Van Nostrand Co., 1928.)

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## REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

*Selected from the Reports made to the Dominion, Colonial  
and Indian Governments*

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### WOOL IN NEW ZEALAND

IN view of the frequent reports of deterioration in the Romney wool produced in New Zealand, investigations are in progress in the Dominion on the breeding, feeding, selection and management of Romney sheep, and an extensive microscopical examination of wool fibres is also being undertaken to ascertain the precise nature and extent of certain wool defects. In this connection the Department of Scientific and Industrial Research, New Zealand, addressed an enquiry to the Imperial Institute Advisory Committee on Animal Fibres regarding the deterioration of Romney wool and the best means of eliminating such undesirable qualities as unevenness of fibre and coarseness.

In order to deal with this subject, it was arranged that the Chairman of the Committee, Sir Frederic A. Aykroyd, Bart., should prepare a memorandum dealing with the problem from the practical requirements of trade and manufacture, and that one of its members, Dr. S. G. Barker, Director of Research of the British Research Association for the Woollen and Worsted Industries, should make an investigation of the wool from the scientific standpoint and prepare a report on the results obtained.

The reports demonstrated clearly that the wool obtained by the crossing of a coarse-woolled sheep with a fine-woolled sheep is intermediate between the wools given by the parent breeds. In some cases this cross-bred wool is uniform, but in other cases is composed of a

mixture of fine fibres and coarse fibres which is very undesirable. Romney wool fibres vary considerably in thickness and in the form or contour of their cross-sections. These defects are much more pronounced in crosses of the Romney sheep with other breeds, such as the Corriedale, and if the practice of crossing indiscriminately with this sheep is pursued, the resulting fibre will soon have to be classed as "hair" rather than wool.

The complete reports furnished by Sir Frederic Aykroyd and Dr. Barker are printed in the following pages.

# I. MEMORANDUM ON DETERIORATION IN SHEEP BREEDING IN NEW ZEALAND

By SIR FREDERIC A. AYKROYD, Bart.

This question was first brought into prominence at the first Conference of Sheep Breeders and Wool Growers which was held in Bradford in September 1924, during the time many breeders and growers were in this country for the Wembley Exhibition—then again in 1925, and subsequently during the present year (1928), when a number of farmers and breeders visited Bradford during the summer.

It is a matter of vital interest to all wool-using countries alike, England, America, Germany, France, Italy, etc., and in the interest of self-preservation should be dealt with by those growing wool for export and consumption abroad and at home.

The Romney Marsh sheep has been favoured in the Dominions for many reasons :

- (1) It is a hardy sheep.
- (2) Can stand damp and is not so liable to foot rot as many other breeds.
- (3) It is a good mutton sheep.
- (4) Cuts a large fleece and a high yielding wool.
- (5) It is free from grey hairs.
- (6) It is reputed to have a greater resisting power against liver fluke and helminthiasis than other breeds.

What then, you ask, are its defects ?

- (1) It runs off very badly at the britch in the wool.
- (2) The quality of the wool is hard.
- (3) It is irregular in quality—each staple containing

a large number of hairs much lower in quality than the bulk quantity.

(4) The fibres come nearer to "hair" in description than wool and vary in thickness between one end and the other.

(5) In sorting wool from the Romney sheep its quality has to be governed by the lowest hair in the staple, making its production uneconomic as the advantage gained by the finer hairs in the staple has to be sacrificed and the price governed by the value of the thick or lower quality hairs.

(6) It has nothing like the same number of serrations per inch as, say, the Leicester or Lincoln or the Corriedale.

(7) Consequently it loses in spinning properties, as the fibres will not cling together, but ride over the top of any other wool mixed with it.

(8) For the Single Yarn Trade (as opposed to the Twofold Yarn Trade)—and this is one of the main old established trades of the country—it is useless and is having to be replaced by South American wool.

(9) In certain cases the result of a cross between coarse- and fine-woolled sheep is the production of a fibre that is intermediate but uniform. In other cases this does not happen, the result being a mixture of fine fibres and coarse fibres. This mixture is especially undesirable.

(10) It is very nearly a Kemp hair and the fear is that ultimately it will breed back to the Kemp or to coarse hair.

(11) In wool growing this is deterioration and is bringing us back to where we were forty years ago.

The inspection of a yarn spun from Romney wool shows how the hairs ride over the main foundation of the yarn and refuse to "bed in" with the rest.

The pure-bred Romney shows the same defects, but, of course, to a much smaller degree than when it is crossed.

In countries where sheep have been allowed to "run riot" a great many of the same defects as that of the Romney are very pronounced.

Evenness in the thickness of the hairs should be aimed at, whether the hairs in the staple be thick or thin.

If the practice of crossing indiscriminately with this

sheep is pursued the product will soon have to be classed as "hair" and not wool.

The sheep to be aimed at should :

(1) Produce good wool of an even thickness in the hairs.

(2) The fleece should be free from grey or black hairs.

(3) Cut a maximum weight per fleece.

(4) Good mutton.

(5) Early mutton.

Science and study can do this, and already great strides have been made in this direction. Experiments have been successfully carried out here in England (only on a small scale) by crossing the Dorset Horn with a copper-coloured ear Wensleydale.

The Dorset is an early and good mutton sheep.

The Wensleydale produces the best long wool known. It is not a flock sheep but only a breeding sheep.

On no account must the blue-eared Wensleydale ram be used, for it throws off 30 per cent. blacks.

It has been proved conclusively that the copper-coloured ear Wensleydale does not throw off any blacks.

It is possible that good results would be got by crossing the Dorset Horn ewe with a Leicester tup, a Border Leicester tup, or a Corriedale tup.

At the present time the best long wool is coming from South America. In some parts of South America the Romney has been used and immediately deterioration sets in.

The basis of the best long wool from South America is the Lincoln and the Leicester.

## II. MEMORANDUM ON PHYSICAL ANALYSIS OF THE ROMNEY, CORRIEDALE AND ROMNEY-CORRIEDALE CROSS-BRED FLEECES

By S. G. BARKER, Ph.D., D.I.C., F.Inst.P., F.R.S.E.

*Director of Research, British Research Association for the Woollen and Worsted Industries*

and C. G. WINSON, B.Sc.

### *Cross-Sectional Area and Contour*

In continuation of the investigation of the relationship of wool quality to spinning power it was suggested by

Sir Frederic Aykroyd that an analysis of the Romney-Corriedale cross might yield interesting results. On the completion of this work it was decided, at the instigation of Mr. H. Clough, to analyse the Romney in similar fashion, and again Sir Frederic Aykroyd suggested further analysis of the Corriedale in order to effect a comparison between the three and thus determine the effects of the cross, if any. The cross-bred fleece was the result of a cross between a Romney ram and a Corriedale ewe.

The present experiments have been limited to the two factors, cross-sectional area as determining fibre thickness, and contour. The question of staple length and other attributes of the fibres is the subject of a separate investigation.

Preliminary experiments showed that there was a notable variability in the cross-bred fleece as regards the fineness of the fibre, and it was clearly of importance in comparative tests between the fleeces that the samples selected should be from similar parts of the fleece in each case. The method of analysis used was that laid down by Barker and Burgess in an earlier paper, and consisted in the accurate determination of the area of cross-section of the fibres, the shape of their contour and the degree of circularity or ellipticity exhibited by them, as indicating some of the attributes of the spinning power of the fibres.

In order to preserve uniformity in the tests and for reasons shown in the report, wool was selected in all cases from the point of the shoulder and the rump. This wool was analysed by selection of groups of fibres and the determination in each group of the area of cross-section and contour, etc., of 500 fibres. The samples were prepared for the cutting of microscopic sections by a modification of the double bedding method of Brecker. The experimental method used is already described by Barker and Burgess (*Wool Record*, 1929, **33**, 823, 883, 951).

### *Treatment of Results*

In the final enlarged image of the fibres the magnification was 1,000 diameters and measurements were made of the two axes of cross-section of the fibres. Throughout the paper the following definitions are adopted.

" A " represents the major axis of the ellipse or the greatest width of cross-section of the fibre.

" B " represents the width of the fibre in a direction at right angles to " A " ; i.e. the minor axis of the ellipse. Hence assuming that the cross-section is elliptical in shape it follows that the cross-sectional area, which is a true measure of the thickness of the fibre, is given by the product of " A " multiplied by " B," multiplied by

$$\frac{3.1416}{4} \text{ or } \frac{\pi}{4}; \text{ that is,}$$

$$\text{Area} = \pi \frac{A.B.}{4}$$

The mean cross-sectional area for any number of fibres is determined as

$$\frac{\pi}{4} \times \text{Mean value of A.B.}$$

As shown previously, the degree of ellipticity is shown by the ratio  $\frac{A}{B}$ , the closer this ratio to unity the nearer the shape to the circular.

### *Numerical Results*

In the consideration of the actual values obtained from the measurements it is obvious that for classification of fibres into groups of the same cross-sectional area, it is only necessary to consider the values of the product A.B., since the actual areas are determined by the multiplication of this value by a constant. Those having the same value for A.B. will therefore be considered as having the same cross-sectional area. Taking the total number of fibres and relating all values to a maximum of 500, tables have been prepared showing the number of fibres coming under each value of cross-sectional area and degree of ellipticity. Table 1 shows the values obtained for the wool from the point of the shoulder, whilst Table 2 shows the values similarly obtained for samples from the rump.

The values have been plotted (Tables 1, 1A, 2, 2A) in the form of frequency curves, for each sample of wool examined. In the tables and in the curves the value of the class interval has been fixed at a convenient value or unit

which is large enough to prevent the tables from becoming unwieldy and yet small enough to lead to proper results

TABLE I. WOOL SELECTED FROM POINT OF SHOULDER

Fleece.	Cross-sectional area. Frequency of values of A.B. 500 fibres.														
	0.2	0.6	1.0	1.4	1.8	2.2	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4	5.8
Romney .	1	23	69	124	121	59	52	31	15	4	1	—	—	—	—
Corriedale .	3	13	34	82	110	129	89	23	11	6	—	—	—	—	—
Romney-Corriedale .	7	35	45	54	58	83	86	58	38	20	11	2	—	1	2

TABLE 1A. CROSS-SECTIONAL DEGREE OF ELLIPTICITY OR CIRCULARITY

$$\text{RATIO } \frac{A}{B}$$

Fleece.	Frequency of values of $\frac{A}{B}$ , 500 fibres.										
	1.05	1.15	1.25	1.35	1.45	1.55	1.65	1.75	1.85	1.95	2.05
Romney . . .	81	101	101	91	62	36	15	9	1	2	1
Corriedale . . .	217	155	75	25	15	6	2	3	—	2	—
Romney-Corriedale.	117	121	94	79	45	23	13	6	1	1	—

TABLE 2. WOOL SELECTED FROM RUMP

Fleece.	Cross-sectional area. Frequency of values of A.B. 500 fibres.														
	0.2	0.6	1.0	1.4	1.8	2.2	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4	
Romney . . .	—	15	69	119	112	81	55	36	10	3	—	—	—	—	
Corriedale . . .	1	3	7	25	58	97	95	113	53	26	14	3	4	1	
Romney-Corriedale	1	9	17	29	35	73	90	76	73	39	29	22	6	1	

TABLE 2A. CROSS-SECTIONAL DEGREE OF ELLIPTICITY OR CIRCULARITY

$$\text{RATIO } \frac{A}{B}$$

Fleece.	Frequency of values of $\frac{A}{B}$ , 500 fibres.										
	1.05	1.15	1.25	1.35	1.45	1.55	1.65	1.75	1.85	1.95	2.05
Romney . . .	96	99	100	85	61	34	15	5	2	2	1
Corriedale . . .	151	139	102	62	20	15	9	1	—	1	—
Romney-Corriedale.	69	113	98	112	60	29	13	3	1	1	1

in assigning the mean value of each class to all the readings contained in that class.

*Discussion of Results*

Let us first consider the number of fibres in each class for the wool taken from the point of the shoulder as is shown by Table 1. From the curves for cross-sectional area it is obvious that the whole range of values for the cross-bred fleece is greater than that for either of the pure-bred fleeces. In the cross-bred fleece we find the range extended to a value of A.B. equal to 5.8, whilst the Romney finishes at 4.2 and the Corriedale at 3.8. This means that there is a considerably greater number of coarser fibres in the cross-bred fleece than in the other two, taken at the same point in the fleece.

An analysis of the figures shows a further interesting point. Table 3 below shows the result of determining the mean values for the results of Tables 1 and 1A.

TABLE 3. FIBRES FROM POINT OF SHOULDER

Fleece.	Mean cross-sectional area.	Mean A.B.	Mean $\frac{A}{B}$ (circularity).
Romney . . .	$9.25 \times 10^{-6}$ sq. cms.	1.82	1.29
Corriedale . .	$10.18 \times 10^{-6}$ „	2.01	1.16
Romney-Corriedale .	$11.25 \times 10^{-6}$ „	2.20	1.24

Taking the mean values for the product A.B. in each case and noting the number of fibres immediately on either side of the mean we find in the case of the three fleeces that over the range 1.4 to 2.2 we have the following values :

Fleece.	Number of fibres in range						Percentage.
	1.4 to 2.2 (A.B.)						
Romney . . . . .	.	.	304	.	.	.	60.8
Corriedale . . . . .	.	.	328	.	.	.	65.6
Romney-Corriedale . . . . .	.	.	223	.	.	.	44.6

This range is selected since in two cases the maximum number of fibres in any class of values occurs within it, and further it contains the mean values of A.B. in all three cases. The figures are significant. Whilst in the two pure-bred fleeces the number of fibres within a small range of thickness is over 60 per cent., yet in the cross the number of fibres over the same range, and still including the mean for the cross, falls to 44.6 per cent. The effect of the cross therefore seems to have been in this case to shift the maximum number of fibres in a particular class

to a class having a higher value for its thickness. We thus find that for the Romney we have a maximum of 124 fibres at 1.4, for the Corriedale a maximum of 129 at 2.2, whilst for the cross we have a much smaller maximum of 86 at a greater thickness of 2.6.

We can thus say that whereas the two pure-bred fleeces have a majority of their fibres in each sample with a small variation of thickness and may be considered as a uniform fineness, yet the cross has a greater variety of thicknesses and shows no such uniformity. A consideration of the results obtained by working out the coefficient of variation in the three cases is of interest. Taking as a measure of the variability the expression :

$$\frac{\text{Mean deviation} \times 100}{\text{arithmetic mean}}$$

we get the following values for the variation of cross-sectional area or thickness :

Fleece.	Coefficient of variation (all results).
Romney . . . . .	30.5 per cent.
Corriedale . . . . .	25.1 „ „
Romney-Corriedale . . . . .	34.9 „ „

The above figures show the order of uniformity of thickness of the fleeces as one would expect from the examination of the fleeces. The Corriedale is the most even, the Romney next, whilst the cross is last of all with the highest coefficient of variation. These facts are better illustrated by the curves, which show the distribution of the fibres over the range and about the mean to be as described above.

Consider next Table 1A and the corresponding curves for the distribution of ellipticity of contour and evenness of shape, in the sample from the shoulder. It is to be noted that a contour ratio of unity would mean circular fibres and the nearer the ratio to unity the nearer to the circular. Previous work by Barker and Burgess has shown that circular fibres in preponderance seem to give a better spinning wool, and this has been proved in a large number of cases examined and actually spun. More results in support of this contention are to be published shortly. We can therefore consider the spinning power

of the wool as affected by contour in the three cases. From the figures of Table 1A we see that in the class of greatest circularity or least ellipticity we have in the case of the three fleeces the following values.

Fleece.	Number of fibres of least ellipticity $\left(\frac{A}{B}\right)$ 1.05.				Percentage.
Romney . . . . .	81	.	.	.	16.2
Corriedale . . . . .	217	.	.	.	43.4
Romney-Corriedale . . . . .	117	.	.	.	23.4

The effect of the cross, therefore, has been to pull down the number of fibres of greatest circularity, and therefore, according to our contention, of best spinning power from 43.4 per cent. to 23.4 per cent. of the total number. Extending the range of our observations to take in the first three columns of Table 1A, and so to include the maximum number of fibres in a particular class in each case, we get the following comparative figures :

Fleece.	No. of fibres of ellipticity $\left(\frac{A}{B}\right)$ 1.05 to 1.25.				Percentage.
Romney . . . . .	283	.	.	.	56.6
Corriedale . . . . .	447	.	.	.	89.4
Romney-Corriedale . . . . .	332	.	.	.	66.4

The result is obvious ; namely, that the cross has had the effect of bringing the good spinning wool down from 89.4 per cent. to 66.4 per cent. of good spinning fibres in a representative sample. Further, it is to be noted that the value for the cross is 23 per cent. below the Corriedale and only 9.8 per cent. above the Romney. A further consideration of the figures for the mean values for circularity as given in Table 3 can now be made. The Romney has the highest ellipticity of an average value in the sample of 1.29, the Corriedale has the least mean value of 1.16, whilst the cross has nearly the Romney value of 1.24. As before, let us consider also the whole range of values to test for uniformity of contour. From Table 1A it is seen, as also from the curves, that the Romney has the widest range of values, whilst the curve is distinctly flatter than for the other two fleeces. The Corriedale has a peaked curve showing the preponderance of fibres of equal or nearly equal value. The cross is closer in form

to the Romney. Working out the coefficients of variation in the three cases as before we get the values :

Fleece.	Coefficient of variation of contour figure $\left(\frac{A}{B}\right)$ (all results).
Romney . . . .	11.6 per cent.
Corriedale . . . .	8.6 " "
Romney-Corriedale . . . .	11.3 " "

The distribution of the shape of fibre cross-section is intermediate between the Romney and the Corriedale, and, as the above figures show, the uniformity of the Corriedale as regards fibre contour is reduced by the cross to almost the figure for the Romney. This would seem to indicate the preponderance of the Romney features in the cross-bred. The figures from the rump samples can now be treated similarly.

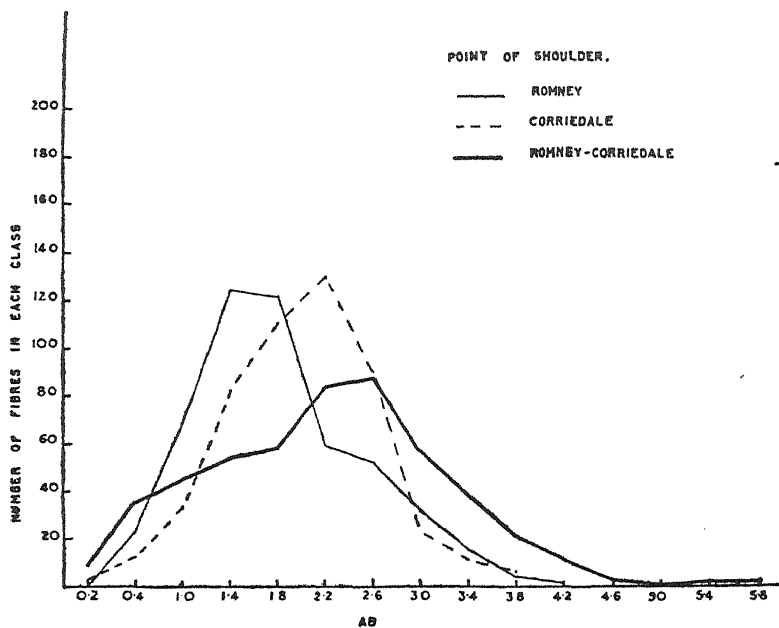
Here, as would be expected, the mean cross-sectional area is in all cases greater than at the shoulder. The range of values for the Romney is shorter than for the other two fleeces, but, as before, the result of the cross is to flatten out the distribution curve and give a greater variation of uniformity in fibre thickness. It is also to be noted that there is a close agreement in average fibre thickness in the case of the Romney between the value obtained for the rump fibres and those from the shoulder. Table 4 shows the mean values obtained for the rump samples.

TABLE 4. MEAN VALUES OF FIBRES FROM RUMP (GROUPS OF 500 FIBRES)

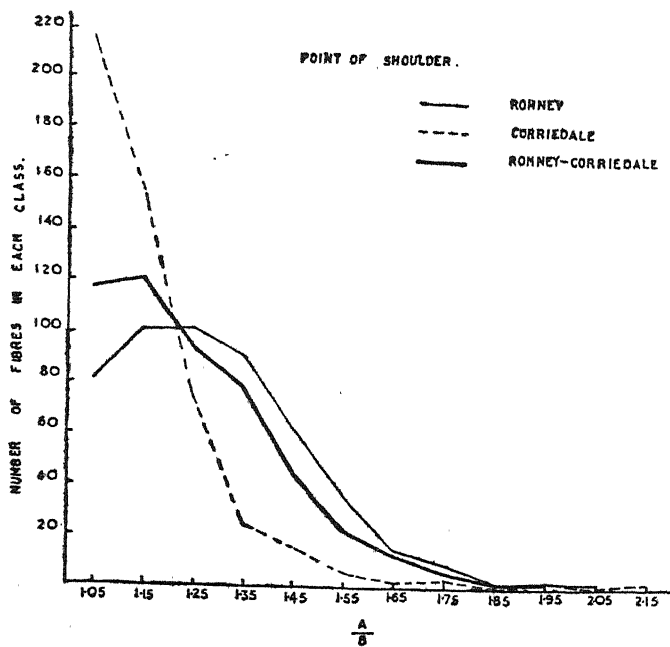
Fleece.	Mean cross-sectional area.	Mean A.B.	Mean $\frac{A}{B}$ (circularity).
Romney . . . .	$9.41 \times 10^{-6}$ sq. cms.	1.86	1.28
Corriedale . . . .	$13.51 \times 10^{-6}$ "	2.67	1.20
Romney-Corriedale . . . .	$14.34 \times 10^{-6}$ "	2.83	1.28

As before, the order of values for fibre thickness is the same, the effect of the cross being twofold : (1) to increase the average thickness, and (2) to decrease the uniformity of thickness in a representative sample. It should be pointed out, however, that the Romney has as good an average as the Corriedale in the present samples, but the cross is much lower. It would almost seem that the value for the cross as regards uniformity of fibre thickness

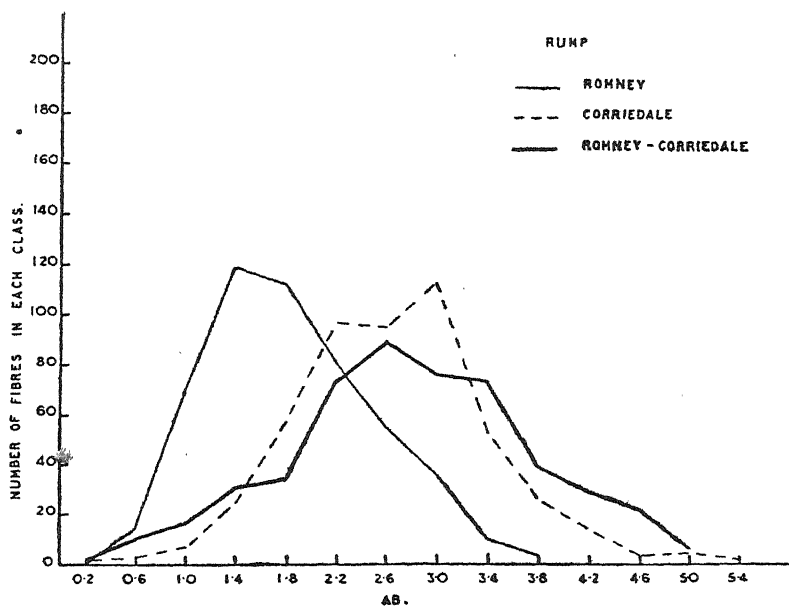
CURVE I.



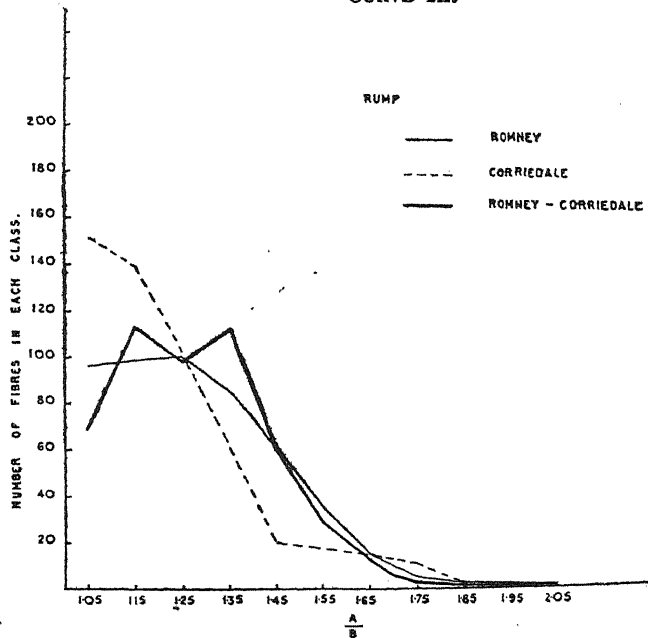
CURVE IA.



CURVE 2.



CURVE 2A.



was lowered because of imperfect mating and the presence of fibres of both breeds in the cross-bred fleece. This is the subject of further examination.

As regards contour and hence spinning power to a certain degree, the figures show precisely the same as before. The curves illustrate the point excellently. The figures and curves for the Romney and the Romney-Corriedale cross are almost identical. Practically there is little difference, as regards contour in the rump sample, between the two fleeces, but a considerable difference from the Corriedale. It is of interest to note that in all cases the fibres at the rump are less circular and more irregular than at the shoulder, in fact the point of the shoulder seems to yield the least elliptical and most regular fibre contour of any part of the fleece. This may account for the reputed good spinning power of fibres from this region. Taking as before the class of greatest circularity (i.e. 1.05 A/B) we find the Romney with 96 fibres, the Corriedale with 151 fibres, whilst the cross has only 69 fibres. Taking again the range of ellipticity as before from 1.05 to 1.25 we get the following table :

Fleece.	No. of fibres of ellipticity $\left(\frac{A}{B}\right)$ 1.05 to 1.25.						Percentage.
Romney . . . . .	.	.	295	.	.	.	59.0
Corriedale . . . . .	.	.	392	.	.	.	78.4
Romney-Corriedale . . . . .	.	.	280	.	.	.	56.0

The result is again obvious. The effect of the cross has been to pull down the percentage of fibres of lowest ellipticity of contour from 78.4 per cent. to 56 per cent. ; that is, the Romney influence has again seemed to preponderate.

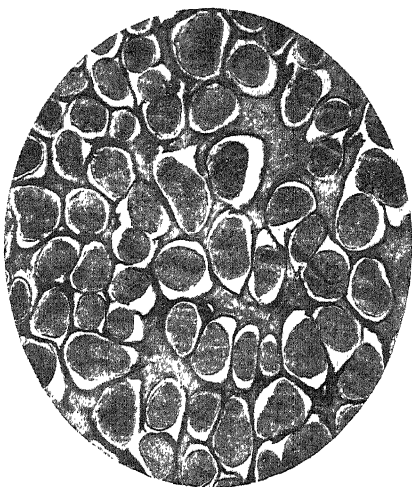
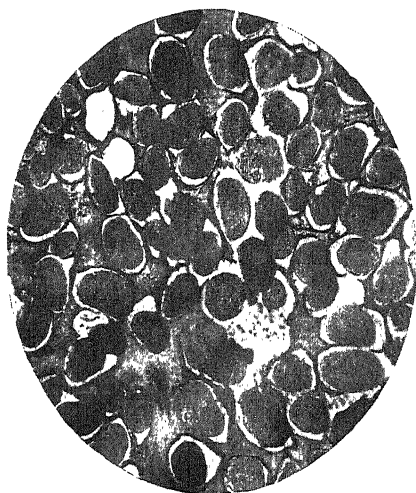
### *Summary of Results*

The essential differences in the three fleeces examined for fibre cross-section and contour are as follows :

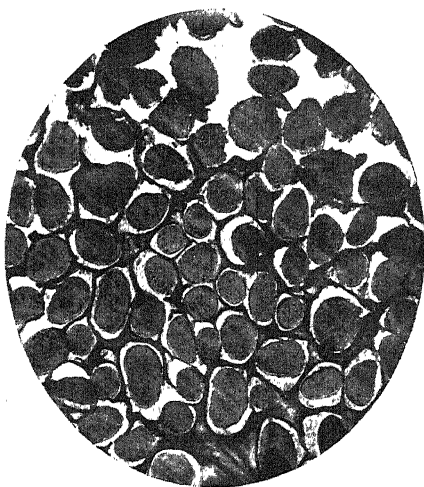
(1) Whereas the Romney and the Corriedale fleeces are of different qualities in different parts of the fleece, each fleece exhibits a moderately high degree of uniformity of fibre fineness. The relative degrees of this uniformity have been shown above.

PLATE I

ROMNEY.



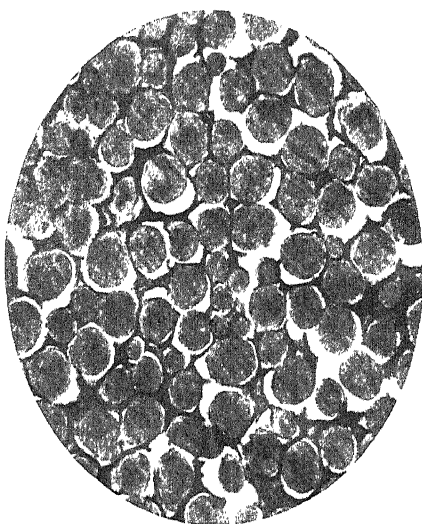
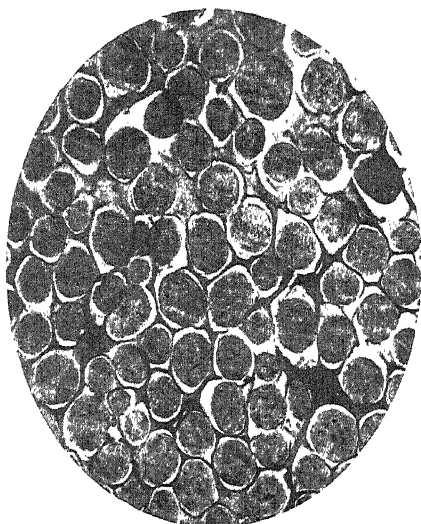
POINT OF SHOULDER.



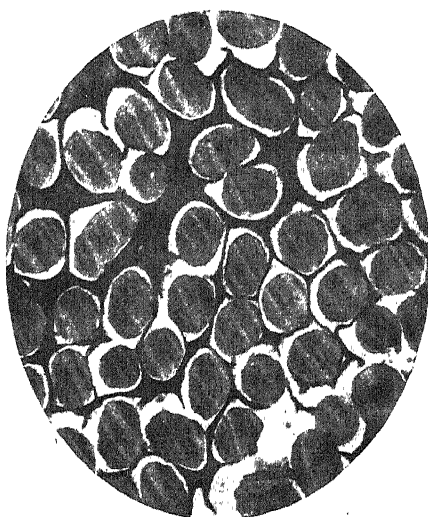
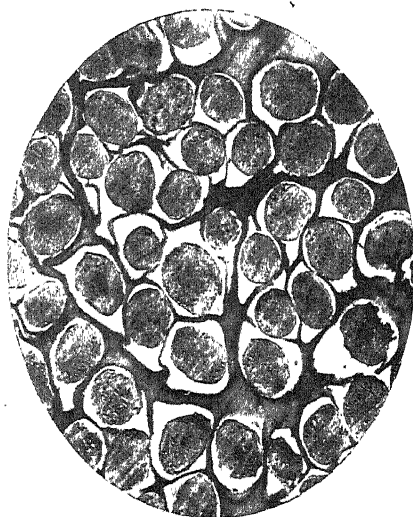
RUMP.

PLATE II

CORRIEDALE.



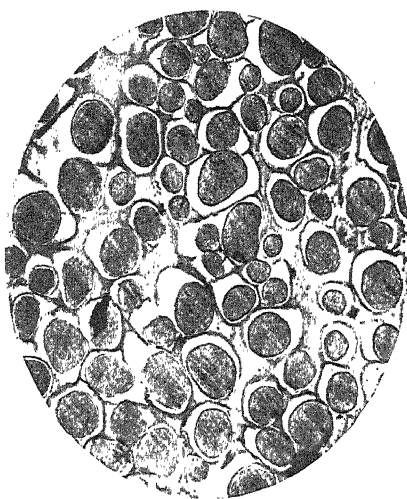
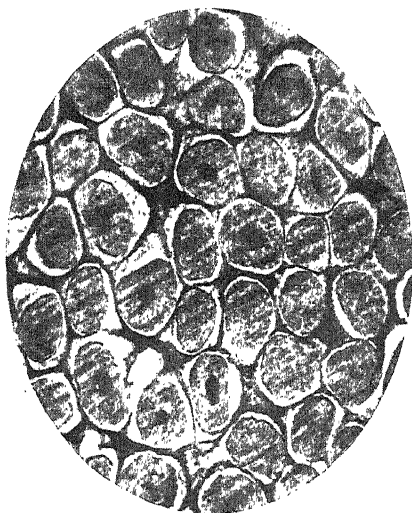
POINT OF SHOULDER.



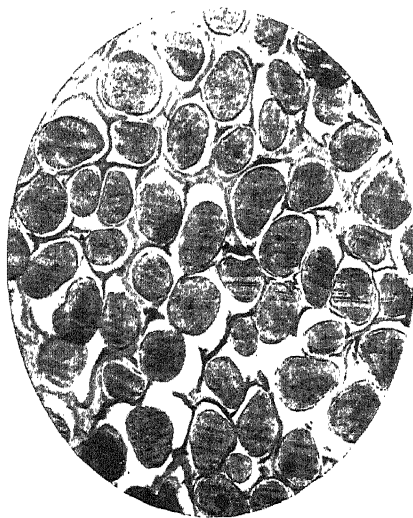
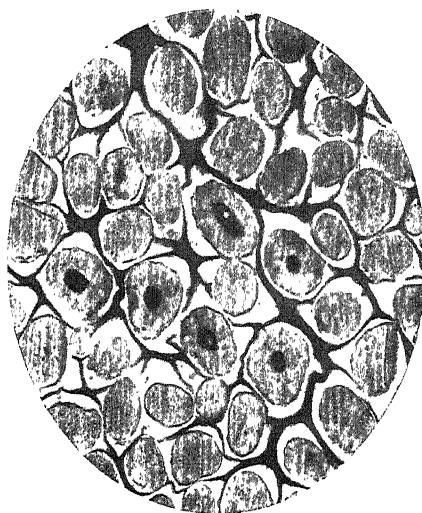
RUMP.

PLATE III

ROMNEY-CORRIEDALE.



POINT OF SHOULDER.



RUMP.



(2) The cross-bred fleece shows much less uniformity than the pure-bred fleeces as regards fibre thickness or area of cross-section.

(3) As regards contour, the variability of the cross-bred is much greater than that of the Corriedale, which is uniform, and approximates more closely to the larger variability of the Romney. The Romney influence preponderates in this respect and hence, according to our contention, the spinning power of the fibres will consequently be reduced accordingly.

Photographs showing the typical cross-sections and contours of the fibres examined are appended. Plate I shows the Romney fleece and gives typical views of the fibres from both rump and shoulder. Plate II gives similar photographs of the Corriedale, whilst Plate III gives similar pictures from the Romney-Corriedale cross.

The striking features of these photographs is the irregularity of shape of the Romney fibres. They are of all shapes, including bean or kidney contour. This unevenness is not found in the Corriedale, which can be seen to be regularly round and almost circular or smooth elliptical. The cross-bred fibres show the irregular characteristics of the Romney to a marked degree.

In conclusion, it is seen from the whole results of the investigation that the contour of the fibres is an important attribute and the findings based upon its investigation in this case are borne out by experience in actual practice.

*Torridon, Headingley, Leeds.*

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## BRICK AND TILE CLAYS FROM THE SUDAN

THE eleven samples which were the subject of this investigation were sent to the Imperial Institute by the Assistant Director, Commercial Intelligence Branch of the Central Economic Board of the Sudan Government, in order that they might be submitted to technical trials as materials for making bricks and tiles.

The samples received for examination were described as follows by the Geological Survey Department of the Sudan.

*Clays Employed at the Mogren Brick Factory, Khartoum*

A. White Clay from pit at Dem Nebawi, north end of Omdurman.

B. Pink Clay from bed of Khor Abu Anga, about 400 yards from its outlet.

C. Nile Silt from the Mogren used in the manufacture of ordinary bricks.

*Clay used for Native Pottery, "Bormas"*

D. Red Clay from bed of Khor Abu Anga, Omdurman. This clay is used for making water jars and has also been tried, mixed with Nile silt, for making Marseilles pattern roofing tiles.

*Samples from the Soba Brick Factory*

E. Normal Nile silt, from river bank, Soba, recent deposit.

F. Good clay silt, recent deposit, surfaces of cracks show iron stains, Soba.

(E and F are used in admixture with H for brick-making.)

G. Older silt with white marks, Soba. This clay contains nodules of lime carbonate which spoil it for brick-making.

H. Sandy silt used for mixing with E. River bank, Soba.

I. Three green bricks to illustrate cracking.

J. Two burnt bricks.

*Cotton Soil*

K. Sample of clay from 6 ft. depth in pit at Research Farm near Wad Medani. This is the only material available over a large part of the Sudan for brick-making.

*Technical Trials*

*Sample A* consisted of a greyish-white clay, which became fairly plastic on the addition of water.

A sample of this material had been examined previously at the Imperial Institute as a fireclay, and the results of tests carried out on that occasion showed that the clay vitrified at a temperature of 1,600° C.

Further refractory tests were made at the Imperial Institute with the present sample of raw clay, and also with the burnt clay (after firing at  $1,400^{\circ}\text{C}.$ ) in admixture with small proportions of sample B. These tests were carried out in accordance with the Institute of Gas Engineers Specifications for grade A and grade B fireclay bricks at  $1,580^{\circ}\text{C}.$  and  $1,670^{\circ}\text{C}.$

The results were as follows :

Mixture.	Behaviour at $1,670^{\circ}\text{C}.$ (Grade A test).	Behaviour at $1,580^{\circ}\text{C}.$ (Grade B test).
Sample A neat . . . . .	Failed (fluid at this temperature).	Vitrified and became pitted.
96 per cent. A + 4 per cent. B . . . . .	—	Failed.
94 " " A + 6 " " B . . . . .	—	Failed.
90 " " A + 10 " " B . . . . .	—	Failed.

These results agree with those previously obtained at the Imperial Institute with the clay, and further show that the addition of sample B to sample A results in a mixture having a lower fusion point than that of the original clay. The clay is therefore unsuitable for the manufacture of either grade A or B refractory bricks.

### *Brick-making Trials*

All the bricks and test pieces made from the brick clays were moulded by the stiff-plastic process in a hand-power screw press.

*Sample K* consisted of a dark-brown clay, which was practically unworkable in its raw state, owing to its extreme stickiness when mixed with water.

This sample was sent in order to ascertain if it could be utilised for the manufacture of building bricks.

The results of tests on a similar sample previously examined at the Imperial Institute showed that the clay was very "fat," had a high shrinkage, and contained calcareous material which caused the fired bricks to crack and split. This defect was not overcome by grinding the clay to pass a 20-mesh sieve prior to moulding.

With the object of reducing the stickiness of the clay, a quantity was heated at a temperature of  $300^{\circ}\text{C}.$  for 3 hours, and was then ground to pass a sieve having 30 meshes per linear inch. When mixed with water this preheated clay was much less sticky than the raw material

and could be moulded fairly easily. Bricks and test pieces were made from the clay thus treated and these, after air-drying, were fired at a temperature of  $980^{\circ}\text{C}$ . The results of tests carried out on these bricks are given below (p. 167).

A further quantity of the sample was heated at  $360^{\circ}\text{C}$ . for 3 hours, and then ground to the same degree of fineness as before. It was found, however, that heating at this temperature caused the clay to lose practically all its binding properties, and hence it was somewhat difficult to mould.

A further series of test pieces were made from a mixture of 80 per cent. raw clay ground to pass a 30-mesh sieve and 20 per cent. grog, the latter being obtained by firing some of the raw clay at about  $1,000^{\circ}\text{C}$  and then grinding it to pass a 30-mesh sieve. It was noticed that this mixture of clay and grog did not mould so readily as did the preheated clay alone. The results of tests made on bricks formed from this mixture and fired at  $980^{\circ}\text{C}$ . are tabulated with those of the preheated clay.

The results show that fairly good bricks can be made from sample K by the stiff-plastic process, provided that the stickiness of the clay is reduced either by (*a*) preheating or (*b*) the addition of grog or other inert material, stronger bricks being obtained when the first method is employed. It is necessary, however, to grind the clay to pass a 30-mesh sieve in order that the lime produced during firing may combine with the clay and so be rendered harmless.

The bricks produced from the preheated clay were hard and of fairly good colour and texture. They contained a number of small surface cracks which did not, however, appear greatly to affect the quality of the ware. Both mould and die require to be well lubricated when using this clay.

In the event of this preheating process being adopted on a commercial scale, accurate temperature control of the kiln in which the operation is carried out would be essential, because (as recorded above) an increase of  $60^{\circ}\text{C}$ . above the maximum temperature found suitable (that is an increase to  $360^{\circ}\text{C}$ .), is liable to yield a product which has a low plasticity and is somewhat difficult to mould.

*Sample G.*—This clay does not appear to have been employed for brickmaking in the Sudan, on account of there being present nodules of chalk, which are stated to render it unsuitable for the purpose.

The sample submitted for examination consisted of a dark-brown clay, which, on the addition of water, became fairly plastic.

A number of bricks and test pieces were made from this material after it had been ground to pass a sieve having 20 meshes per linear inch, and after drying the ware was fired at 980° C. As it was found, however, that at this temperature very weak bricks were produced, the maximum firing temperature was raised to 1,050° C., with fairly satisfactory results. The results of tests carried out on bricks fired at this higher temperature are appended (p. 167).

The technical trials carried out at the Imperial Institute showed that moderately good building bricks could be made from this clay (G) by the stiff-plastic process if the material was ground to pass a 20-mesh sieve, but the employment of coarser material resulted in "blowing" of the finished brick. The clay could be moulded easily and the ware had little or no tendency to warp on drying and firing, but the fired bricks were not so hard as those produced from sample K. It is probable that the addition of a small quantity of either sample B or sample D would reduce considerably the somewhat high porosity of the bricks made from the neat clay, but owing to the small quantity of material available, it was impossible to conduct any experiments in this direction.

#### MARSEILLES PATTERN ROOFING TILES

The Imperial Institute had been requested to ascertain whether clays C, E and F (with or without the addition of a proportion of sample H) could be used for making Marseilles pattern roofing tiles, and technical trials were accordingly carried out on these lines. As a matter of interest similar tests were made with clays D and G.

Except where otherwise stated metal moulds were used for pressing the tiles, as by this means less water was required for tempering the clay, and consequently

the time occupied in drying the tiles was reduced considerably.

It will be observed that in some of the trials recorded below tests were made on tiles fired at different temperatures, the object being to ascertain whether sufficiently strong products could be produced at temperatures approximating to those obtainable in the kilns fired with the wood fuel available in the Sudan, and not to determine the greater strength obtainable at higher temperatures.

*Sample C.*—This consisted of a dark-brown clay, which became very sticky on the addition of water. All tests on this clay were carried out on the material ground to pass a sieve having 20 meshes per linear inch.

Considerable difficulty was experienced in working the neat clay, on account of its stickiness and tendency to adhere to the moulds. Some improvement in this respect was effected by mixing 80 per cent. of this clay with 20 per cent. of sample H, but more successful results were obtained by substituting plaster-of-Paris moulds for the metal ones hitherto employed. The tiles made by this method were air-dried and fired at  $980^{\circ}\text{C.}$ , and the results of the physical tests on these are shown on p. 167.

*Sample E.*—This was very similar in appearance to sample C, and the above remarks concerning that sample are in all cases applicable to this material, which behaved in a similar manner.

*Sample D.*—This was a reddish-brown clay, which became plastic on the addition of water. Before use it was ground to pass a sieve containing 20 meshes per linear inch, and all tests were carried out with this material. It was found that the clay moulded very well in metal tile moulds, no excessive lubrication being required. No difficulty was experienced in removing the freshly made tiles from the mould, but they cracked badly on drying.

Mixtures of the clay were also made with sample H, and were found to have equally satisfactory working properties, but in one case cracks developed on drying. After air-drying, these tiles were fired at  $980^{\circ}\text{C.}$ , and their characteristics are shown in the table on p. 167.

Fairly good tiles were made from a mixture of 60 per cent. D with 40 per cent. H, but their strength was some-

Marseilles Tiles.															
Bricks.				Marseilles Tiles.											
80 per cent. Clay K + 20 per cent. Clay K + 300° C. and fired neat.	Clay K pre-heated at 300° C. and used neat.	Clay G used neat.	80 per cent. Clay C + 20 per cent. Clay H.				80 per cent. Clay E + 20 per cent. Clay H.				Clay D + 20 per cent. Clay H. (Metal moulds.)	Clay D + 40 per cent. Clay H. (Metal moulds.)	Clay G used neat. (Metal moulds.)	Clay F used neat. (Metal moulds.)	
			(Metal moulds.)	(Metal moulds.)	(Plaster moulds.)	(Metal moulds.)	(Metal moulds.)	(Metal moulds.)	(Plaster moulds.)	(Metal moulds.)					
13.7%	12.7%	13.3%	16.10%	16.10%	*	17.7%	17.7%	15.8%	16.2%	80 per cent. Clay D + 20 per cent. Clay H. (Metal moulds.)	80 per cent. Clay D + 20 per cent. Clay H. (Metal moulds.)	60 per cent. Clay D + 40 per cent. Clay H. (Metal moulds.)	19.1%	17.9%	
980° C.	980° C.	1,050° C.	1,050° C.	980° C.	980° C.	980° C.	980° C.	980° C.	980° C.	980° C.	980° C.	980° C.	1,050° C.	980° C.	
6 hours	6 hours	6 hours	6 hours	6 hours	6 hours	6 hours	6 hours	6 hours	6 hours	6 hours	6 hours	6 hours	6 hours	6 hours	
6.9%	5.9%	5.2%	6.0%	6.0%	9.3%	7.0%	7.0%	7.2%	6.8%	5.7%	8.7%	7.4%	3.5%	3.8%	
3.0%	5.0%	3.7%	3.9%	2.0%	3.2%	2.5%	1.5%	2.8%	1.5%	0.8%	3.5%	3.8%	12.2%	11.2%	
9.9%	10.9%	8.9%	9.9%	8.0%	12.5%	9.5%	8.5%	10.0%	8.3%	6.5%	12.2%	11.2%	12.2%	11.2%	
25.00%	21.20%	35.29%	*	*	*	*	*	*	*	*	*	*	*	*	
12.92%	10.15%	20.16%	19.45%	20.39%	20.33%	19.80%	20.74%	18.94%	15.55%	17.01%	16.23%	15.03%	16.23%	15.03%	
2,855 lb. per sq. in.	4,933 lb. per sq. in.	4,594 lb. per sq. in.	—	—	—	—	—	—	—	—	—	—	—	—	
Dark terra cotta	Dark terra cotta	Dark terra cotta	Dark terra cotta	Terra cotta	Terra cotta	Dark terra cotta	Terra cotta	Terra cotta	Brownish terra cotta	Brownish terra cotta	Brownish terra cotta	Brownish terra cotta	Rather dark terra cotta	Terra cotta	
Fairly good	Fairly good	Fairly good	Fairly good	Rather poor	Good	Fairly good	Poor	Good	Fairly good	Fairly good	Fairly good	Fairly good	Rather poor	Fairly good	
Colour of fired ware .	Colour of fired ware .	Colour of fired ware .	Colour of fired ware .	Colour of fired ware .	Colour of fired ware .	Colour of fired ware .	Colour of fired ware .	Colour of fired ware .	Colour of fired ware .	Colour of fired ware .	Colour of fired ware .	Colour of fired ware .	Colour of fired ware .	Colour of fired ware .	
Ring . . . .	Ring . . . .	Ring . . . .	Ring . . . .	Ring . . . .	Ring . . . .	Ring . . . .	Ring . . . .	Ring . . . .	Ring . . . .	Ring . . . .	Ring . . . .	Ring . . . .	Ring . . . .	Ring . . . .	

\* Material insufficient for these tests to be carried out.

<sup>1</sup> Bricks crushed face downwards.

what low. There was also a tendency for the tiles to "scum" slightly after being wetted. This "scumming" could be eliminated by adding a small percentage of barium carbonate to the clay before moulding.

*Sample G.*—This clay worked fairly well, but had a tendency to stick to the metal mould, in spite of the latter having previously been lubricated. A number of tiles were moulded from the neat 20-mesh clay as used in the brick experiments described on p. 165, and after air-drying were fired at 1,050° C. The fired products showed no signs of serious cracking, but were somewhat weak.

The results of tests made on these tiles are shown on p. 167.

*Sample F* consisted of a dark-brown clay, fairly sticky when mixed with water. The sample used for the tests was ground to pass a sieve having 20 meshes per linear inch, and on moulding it was found that the clay behaved in a similar manner to samples C and E. Mixtures of the clay with sample D and a small percentage of H were made with a view to decreasing the shrinkage and improving the moulding properties, but no great improvement was effected.

The tiles made from the neat clay were air-dried and fired at 980° C. A certain amount of cracking took place, but apart from this defect, the tiles were fairly strong and had a comparatively low water-absorption.

The above results indicate that pressing in metal moulds does not appear to be a suitable process for treating this clay, which has a strong tendency to adhere to the mould. The clay also requires the addition of some inert material in order to eliminate its tendency to crack on drying and firing, but unfortunately this has the effect of still further reducing the low binding qualities of the clay and renders moulding more difficult.

All these clays, with the exception perhaps of B and D, are of a "sticky" rather than a plastic nature. Any attempt to reduce this stickiness results in the reduction of their already low "binding power" and makes satisfactory moulding still more difficult.

The technical trials also showed that it is possible to make Marseilles pattern roofing tiles from these clays, but

the difficulties of manufacture are great. The use of metal moulds and a comparatively dry clay paste is not recommended in all cases on account of the tendency of the clays to stick to the mould, but this difficulty can be overcome by the use of plaster moulds, much stronger products being thus obtained. It would appear probable, however, that the adoption of plaster moulds would not be likely to prove successful for the manufacture of tiles as the use of a wetter clay paste would be necessary, and the difficulties of drying would consequently be increased.

#### SUMMARY AND CONCLUSIONS

*Bricks.*—The technical trials show that fairly good building bricks can be made from sample K by the stiff-plastic process, provided that the clay is finely ground, and that its stickiness is reduced either by preheating or the addition of some inert material. It is probable that the semi-dry process could also be used under similar conditions, but it would be advisable to carry out further tests in order to confirm this opinion.

Bricks of inferior strength, but nevertheless suitable for most building purposes, can be made from the neat clay G by the stiff-plastic process. Fine grinding is essential as the clay contains nodules of chalk.

*Tiles.*—Moderately good Marseilles pattern roofing tiles can be made from clays C and E with an admixture of H, using plaster of Paris moulds. A mixture of samples D and H can be worked by the metal-mould method and produces fairly good tiles. Sample G seems to require the addition of a plastic clay in order to reduce the porosity and increase the strength of the finished tile. Sample F is somewhat similar in its working qualities to clays C and E and it appears likely that it would be best adapted to the plaster-mould method of manufacture.

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### ARTICLE

#### THE WATTLE BARK INDUSTRY

IN Part I of an article on "Tanning Materials of the British Empire," published in this BULLETIN (1927, 14, 251), an account is given of the production of wattle

bark in South Africa, Kenya, Australia and other countries of the Empire. Although wattle bark has now an established position among tanning materials and is used by tanners not only in this country, but also on the Continent and in the United States, the profitable production of the bark depends to a large extent on the market which can be found for by-products of the industry, especially the wood which remains after the bark has been removed from the trunks. It has been thought desirable therefore to give in the present article an account of the attempts which have been made to utilise these by-products and to discuss the bearing of the question on the future of the wattle-bark industry in countries of the Empire. Reference is also made to the efforts now being undertaken in South Africa to improve the industry in that country from the cultural standpoint. Before dealing with these matters, however, it may be useful to give a brief summary of the present production in the Empire.

#### I. PRESENT POSITION OF THE WATTLE BARK INDUSTRY IN THE EMPIRE

The wattles, sometimes referred to as mimosas, are characteristic Australian plants belonging to the genus *Acacia*. The forms which are of importance as a source of tanning bark are the black wattle (*Acacia decurrens* var. *mollis* Willd. = *A. mollissima* Willd.), golden wattle (*A. pycnantha* Benth.) and, to a much less extent, the silver wattle (*A. dealbata* Link). The trees have been introduced into a number of countries outside Australia and in certain of them the conditions have proved highly satisfactory to their growth. This is the case particularly in Natal, where the black wattle, introduced some sixty years ago for ornamental purposes and as shelter-belts for stock, is now grown on an extensive scale for the production of bark. At the present time the production of wattle bark in Australia is insufficient to meet the demands of the local tanners and large quantities are imported from Natal.

Since the introduction of the wattle into South Africa, the cultivation of the tree for bark has made very rapid

strides in Natal, and to a less extent in the other Provinces, the total area under cultivation in 1926 being as follows :

	<i>Acres.</i>
Natal . . . . .	231,211
Transvaal . . . . .	49,178
Cape of Good Hope . . . . .	27,847
Orange Free State . . . . .	1,943
Total . . . . .	<u>310,179</u>

At first the Natal product was shipped only in the form of bark (chipped, ground or otherwise prepared), but in 1916 a factory was erected in Pietermaritzburg for the preparation of tanning extract, and others soon followed in various localities. The industry made rapid strides, and at present a large proportion of the output of bark is exported in the form of extract, as is shown by the following figures of the exports of bark and extract from the Union in 1927.

	<i>Quantity. Short tons.</i>	<i>Value. £.</i>
Wattle Bark . . . . .	105,285	868,268
Extract . . . . .	17,361	291,384
Total value . . . . .		<u>1,159,652</u>

The Australian wattle bark industry has been dependent on wild trees and the diminution in production which has taken place during the past twenty years or so has been due to the depletion of the readily accessible forests. The establishment of plantations on a scale comparable with the Natal industry has not hitherto been practicable in Australia owing especially to the higher cost of labour in the Commonwealth. There are, however, relatively small areas of plantations of golden wattle in Victoria and South Australia.

It is not possible to give figures of the total production of wattle bark in Australia, the bulk of which appears to be used locally. The export of the bark is not shown separately in the official trade returns and most of the "tanning barks" shown in the export tables consists of mallet bark from Western Australia.

The black wattle was introduced into Kenya Colony about 1903 with a view to providing fuel on the Uganda railway ; subsequently consideration was given to the

possibility of producing tanning bark. The first shipment, of 10 tons, was made in 1910, and the industry showed signs of making satisfactory growth until the war and high freights prevented the export of bark. In 1920 the shipment of bark in quantity recommenced, the maximum in subsequent years being 3,570 tons in 1924. Since the latter year the export of bark has declined, but this is to be attributed in large part to the fact that tanning extract is now prepared in the Colony, a factory for this purpose having been established in 1923. The exports of bark and extract in 1927 were as follows :

	Quantity. Long tons.	Value. £.
Bark . . . . .	2,204	17,338
Extract . . . . .	1,062	19,188

Other British countries where wattle has been introduced, but which at present produce relatively insignificant quantities of bark, are India, Ceylon, Nyasaland, Tanganyika, New Zealand and Seychelles.

## II. FUTURE PROSPECTS

The sound position of the Natal industry is due to a combination of conditions, chief among which are (1) the eminently suitable environment, which favours the rapid growth of the tree and enables the bark to be stripped if required within five or six years from the time of planting ; (2) a plentiful supply of cheap labour ; and (3) a ready local market for the wood (left after the bark has been stripped) for use as pit props and as fuel. The market for Natal bark and extract is now thoroughly established both in this country and on the Continent (particularly in Germany), whilst the bark is becoming better known in the United States, where the Tanners' Council of America are undertaking propaganda work to encourage its use in American tanneries. It has been estimated that about 50 per cent. of the tanning materials employed in the United States consists of locally produced chestnut bark. The chestnut trees in the Eastern States, however, have been attacked by a blight and it is anticipated that the domestic supply of chestnut bark will be cut down to very small proportions by 1930. The country will

therefore have to depend more in the future on imported materials, among which wattle bark will doubtless occupy an important position.

There seems little doubt therefore that any increased production of wattle bark that might be effected in South Africa in the future will find a ready market.

As regards East Africa and Australia the position as to the future is not so satisfactory. The former region is at a disadvantage in not having at present a ready local market for the wood, which, as already mentioned, is an important factor in the success of the Natal industry. Should it be found possible, however, to utilise the wood in any other way than as pit props and fuel and to find a use for the spent bark produced at the extract factory, the position would be materially improved.

The difficulties met with in Australia in regard to the establishment of plantations have been mentioned in the previous section. The opinion has been expressed that Australian wattle bark can only hope to compete with the Natal bark when some mechanical means has been devised for stripping the bark, thus reducing the labour costs, whilst success will also depend in part, as in East Africa, on the utilisation of the by-products.

Of other British countries India appears to be the most promising as a future source of supply of wattle bark. The black wattle has been shown to grow well in Southern India, but the local requirements for tanning materials are so large that the production would have to be increased to a very great extent before any is available for export.

In connection with the future of wattle bark in the Empire, two points must be taken into consideration: (1) competition of the bark with other tanning materials, and (2) possible competition with foreign countries as sources of supply. As regards the first point there seems little reason to doubt that wattle bark will continue to hold its own. The Tanners' Council of America, in a memorandum on the qualities of the bark, point out that its chief value lies in its quick penetration, good colour, capacity to blend with other tannins and tendency to dissolve insoluble tans. The tanning value of the material

may therefore be said to be well recognised and there need be no apprehension on this score.

Practically all the materials with which wattle bark competes, such as quebracho and oak and hemlock barks, are obtained from wild sources. The readily accessible forests of quebracho are becoming depleted and it is believed that the time is within sight when it will become necessary to make plantations, if the extraction of the material is to be remunerative. In this respect wattle has, owing to its rapid growth, a marked advantage over its competitors. It has been estimated that 6 tons of bark, containing an average of about 37 per cent. of tannin, can be obtained per acre in from seven to ten years in the case of wattle, whilst it would take eighty years for oak and hemlock to produce 4 and 8 tons, respectively, of bark containing in each case only about 12 per cent. of tannin; quebracho also takes a very long time to mature, but possibly not so long as oak and hemlock.

In view of the decreased production of chestnut bark in the United States, the Department of Commerce instituted a survey into the tanning materials of the world and in a report published as "Trade Information Bulletin No. 211" advocated the planting of wattle in the States and contiguous countries and also in Territories under their control. The Empire therefore has a possible future competitor in this direction. Much attention has also been given to the growing of wattle in Madagascar. Other foreign countries which are at present growing wattle on a small scale or experimentally include Morocco and Java, whilst its cultivation has also been suggested in Sicily and the Landes district of France. The position in all these countries is not sufficiently advanced to warrant any conclusions being drawn at present as to the extent to which they may become competitors of British countries in supplying the world's demand for wattle bark, but it will be necessary to keep a careful watch on developments, more particularly perhaps in Madagascar, and possibly Java.

With a view to improving the wattle bark industry in South Africa, the Forest Department of the South African Government are undertaking a comprehensive

scheme of silvicultural research in co-operation with the Wattle and Timber Growers' Association. It is proposed to set up experimental plots in different localities from south-eastern Transvaal to southern Natal, on which observations and measurements will be carefully made and recorded, dealing with every phase upon which there is divergence of opinion. Some of the more important aspects which will be studied include annual growth measurements over the period of rotation, showing maximum height and volume increment under various conditions. The data thus collected will enable the growers or prospective investors to estimate accurately the amount of wood and weight of green or dry bark per acre in a plantation of any age, if the site quality is correctly assessed. From standard yield tables so compiled, it will be possible to determine the age at which the crop must be felled in order to obtain the highest financial returns. The effect of espacement on the yields of bark and wood at any age in different localities is also to be ascertained, and whether the costs of clean cultivation and the continuous removal of grass are justified by results. Other experiments will be carried out to decide whether the popular practice of burning for the disposal of slash, and for the alleged good germination of seed which ensues, really produces beneficial results; whether the black wattle (variety *mollis*) or the green wattle (variety *normalis*) furnishes the better returns on land infested with the froghopper and bag-worm. In all experimental plots data will be collected on the incidence and extent of insect attacks, and experiments will be conducted to discover the most effective fertilisers, and the most suitable amounts of each to be applied per acre.

In the Annual Report of the Wattle and Timber Growers' Association, dated March 20, 1929, it is mentioned that the Association has secured the co-operation of thirteen wattle estates in different parts of Natal on which experimental work will be carried out and that 321 permanent sample plots have already been planned. Work is also being conducted on methods of control of the wattle bag-worm, a serious pest of the tree, including the question of varieties resistant to the pest and the

possibility of introducing parasites which destroy the insects. The results of investigations already carried out on the tannin content of wattle bark and on the manuring of the tree have been published recently by the Department of Agriculture.

### III. UTILISATION OF BY-PRODUCTS

In harvesting wattle bark, the trees are notched with an axe and the bark peeled off. The trunk which remains is then cut down and the branches and twigs lopped off. Only the bark itself is sufficiently rich in tannin to be worth exporting; the wood contains practically no tannin, whilst the branches and twigs contain relatively so little that hitherto no use has been made of them as a source of tannin. Suggestions have been made in South Australia that the loppings of the golden wattle might be used for the preparation of tanning extract and as a source of distillation products, and experiments have been made in these directions. Further work on the subject needs to be done before it can be said whether such utilisation would be profitable when the wattle is grown on plantations. At present it is the custom to burn the loppings on the ground, a practice which is beneficial to the regeneration of the plantation since the fallen seeds, which have a very hard seed-coat, germinate more readily after being subjected to the heat.

The only material remaining on the plantation for which a market has to be found, after the bark is harvested, will therefore be the wood. In countries where tanning extract is manufactured there will also be the spent bark to be disposed of.

The question of the utilisation of the wood and the spent bark has received much consideration, as it has long been recognised that they constitute an important potential source of revenue. In South Africa the plantations within easy reach of the railway have hitherto found a ready market for trunks of suitable size and shape as pit-props for use in the mines, whilst the remainder of the wood can be sold as firewood, for which purpose it has excellent qualities. There are, however, many areas (possibly amounting to one-half or more of the total)

too far distant from the railway to render it profitable to transport the wood for sale for these purposes. Moreover, it is understood that the demand for wattle as pit-props is falling off, owing to the competition of Eucalyptus props and to the growing use of props made of concrete.

The quantity of wattle wood, therefore, which at present has to be burnt as waste in Natal alone must reach a large figure. The amount of marketable wood produced per acre in that country has been variously estimated at from 20 to 45 tons per acre during a rotation period of six to ten years. Taking, as a basis of calculation, the yield to be 30 tons over eight years and assuming that, say, 120,000 acres out of the present area of 231,000 acres in Natal are beyond the reach of railways, it would seem that some 450,000 tons of wood, apart from branches and twigs, are being wasted each year. The question of utilising this wood, which is scattered over wide areas, naturally presents great difficulties, but the problem is such an important one that it deserves the closest consideration.

Wattle wood splits easily and provides useful timber for farm purposes, such as for posts, rails, etc. It does not, however, last well in the ground, even when tarred, and in any case the quantity which can be utilised in this way is relatively small.

In Australia the wood of mature trees has been used for paving blocks, but the rapid growth of the tree under plantation conditions so alters the character of the wood as to make it quite unsuitable for this purpose.

The Department of Forestry, Union of South Africa, are conducting an enquiry into the possible uses of the wood as sawn timber and in this connection investigations have been made recently into the seasoning of the wood. The results are stated to have been very good and no defects due to the seasoning process occurred.

The directions in which it seems possible that an outlet may eventually be found for the wood are as a paper-making material and as a source of charcoal, acetic acid and its derivatives, methyl alcohol and tar by destructive distillation. A summary of experiments which have been made to utilise the wood for these purposes and of trials

of the spent bark as a paper-making material is given below.

A possible further application of the wood is as a source of cellulose for the manufacture of artificial silk. On this point, however, there would appear to be no published information and an investigation of the subject is desirable.

(a) USE OF WASTE WATTLE WOOD AND SPENT BARK FOR  
PAPER-MAKING

Experiments were conducted at the Imperial Institute in 1917 and 1918 to determine the suitability of wattle wood and spent bark for the production of paper pulp (see this BULLETIN, 1917, 15, 496). The results were fairly satisfactory, and it was found that both materials are suitable for making certain qualities of wrapping papers. The fibres of the wood were, however, short, and it would not be possible to make a strong paper from this material alone. Possibly the most satisfactory method of employing the wood and bark would be to use them together in suitable proportions for the manufacture of millboard or "strawboard" which would find a ready market in both South Africa and Australia for packing fruit and for other purposes.

Some difficulty was experienced in the case of the spent bark, which in the untreated state produced a paper containing small black specks that appeared to be derived from the corky portion of the bark and resisted the action of the alkali used in preparing the pulp. It was found by experiment that a large proportion of the corky material could be removed by sieving or by beating the bark in a pulp-beating machine, and bark so treated produced a paper practically free from specks.

In 1920 statements appeared in the press that a company was in process of formation in South Africa for making paper from spent wattle bark. A Norwegian paper-making expert investigated the question on behalf of the company and tests were carried out with both wood and bark on a fair scale in Norway. The pulp was prepared by the sulphate process. The expert's report confirmed the results obtained at the Imperial Institute,

but it was found that great care had to be exercised during the cooking process owing to the tannin remaining in the bark. If the temperature was raised too rapidly to the normal required for cooking, the tannin became charred, producing a pulp full of black powdered "coal" which would be quite unsuitable for paper-making. This difficulty was overcome by first cooking with alkali for about an hour at atmospheric pressure, after which the temperature could be raised rapidly to 140–145° C., corresponding to a pressure of 3–3.5 kilo. per sq. cm.

As a result of his tests the expert concluded that the bark pulp is suitable for strong wrapping papers and boards, and that the wood pulp could be used for the cheaper grades of wrapping papers. He considered that pulp of excellent quality for making all kinds of strong wrapping paper could be made by mixing three parts of wood pulp with two parts of bark pulp. He pointed out, however, that the consumption of alkali in preparing the pulp is high, and to be an economical proposition, it would be necessary to recover the alkali from the waste liquors.

A process for manufacturing millboard from spent wattle bark was patented by A. T. Masterman in 1921 (Patent Specification 182,884). The bark is crushed in an edge runner, being treated at the same time with a solution of carbonate of soda or other alkali. It is stated that by this means the bark is not only broken up, but it is softened, the fibres are isolated and the greater part of the tannin extracted so that the subsequent beating process is shortened. The crushed bark is then mixed with waste paper pulp (say 20 or 30 per cent. by weight) and beaten for about two hours with water at from 45 to 50° C., size and alum being incorporated during the process in the usual manner. It is claimed that millboard prepared in this way is non-conducting to heat and of less weight than board made from waste paper alone.

So far as the Imperial Institute is aware, there is as yet no commercial production of paper from either the wood or spent bark. To utilise these materials profitably it would probably be necessary to erect a pulp mill in the immediate vicinity of the supplies, owing to the cost of transport of the raw materials. This applies especially

to the spent bark, which contains from 40 to 70 per cent. of water. The pulp could then be transported to a paper mill or, if supplies are in excess of local demands, shipped overseas. The site for the pulp mill would need to be selected with great care, due consideration being given to the question of water supply, fuel, and availability of the chemicals required.

#### (b) DISTILLATION OF WATTLE WOOD

When a hardwood, such as wattle, is subjected to destructive distillation four products are obtained, viz. : (1) an inflammable gas ; (2) a watery liquid, known as pyroligneous acid ; (3) wood tar ; and (4) charcoal. All these products are of industrial value. The gas can be burnt for heating the retort ; the pyroligneous acid on re-distillation yields acetic acid (which is collected as acetate of lime), wood spirit (methyl alcohol) and tar ; the latter, with the wood tar obtained by the first distillation, finds a great variety of uses, both in its original state and in the form of products obtained by its distillation, such as wood oils, creosote, pitch, etc. ; finally, the charcoal can be employed in gas suction plants, for insulation purposes, filtration, sugar refining, smithy work, in admixture with poultry and pig foods, and for many other purposes.

The demand for these various products in South Africa, Australia and other countries where wattle is grown is not large, but they could probably find a market in this country. At present most of the acetic acid, acetate of lime, acetone (prepared from the latter), methyl alcohol and wood tar imported into Great Britain is obtained from foreign sources, Canada being the only country within the Empire where wood distillation is carried out to any extent. The establishment of distillation works in the wattle-growing countries is to be commended, therefore, not only as a means of utilising the wattle wood and so increasing the prosperity of the industry, but also as enabling the home country to obtain products from Empire sources, which are at present chiefly provided by foreign countries. Before embarking on the preparation of these products by the distillation of wattle wood, careful

consideration would need to be given to the possible competition of acetone and methyl alcohol prepared by synthetic processes.

As long ago as 1907 the Imperial Institute had under consideration the question of utilising Natal wattle wood for distillation and the matter has been raised repeatedly since then. In his evidence before the Dominions Royal Commission in 1914, Mr. Fraser, a Natal wattle grower, put forward detailed suggestions for the establishment of the industry. He was of the opinion that seven centres in Natal could at that time support distillation factories, five of them each capable of treating 30,000 tons of wood per annum and the other two 20,000 tons each, a total of 190,000 tons annually. The acreage of trees served by these factories within easy reach of the railway he considered would be 105,000 acres. He suggested that a carbonising plant should be located in each of these seven centres with a central refinery for treating all the products. His estimate of the yield of the different products, based on trials conducted in this country in 1912, was as follows :

	Yield from 100 tons of wood.
Charcoal . . . . .	20 tons
Acetate of lime (82 per cent.) . . . . .	5.5 "
Crude wood spirit . . . . .	1.4 "
Tar . . . . .	6.7 "

In 1916 the Imperial Institute carried out small-scale distillation trials with black wattle wood obtained from Kenya (see this BULLETIN, 1916, 14, 570). The results, which are given in summary below, in comparison with the usual results for oak wood on a factory scale, conform very closely to Mr. Fraser's figures :

	Black wattle. (Average of two tests.)		Oak wood. (Factory results.)	
	Per cent.	Per ton.	Per cent.	Per ton.
Charcoal . . . . .	27	605 lb.	26	580 lb.
Acetate of lime. . . . .	6.2	139 lb.	5.0	112 lb.
Wood spirit . . . . .	1.2	3.7 galls.	1.1	3.25 galls.
Tar . . . . .	6.0	134 lb.	4.5	100 lb.

The Imperial Institute is informed that large-scale distillation trials (with 10 tons of black wattle wood from South Africa) carried out by a firm of wood distillers in this country, also gave very satisfactory results.

Trials which have been carried out on golden wattle wood in South Australia and on black wattle wood in India have given equally favourable results and there seems no doubt that the possibility of establishing distillation factories, in Natal at least, is worthy of the fullest consideration.

(c) MANURIAL VALUE OF THE ASH OF WATTLE WOOD AND BARK

In view of the fact that such large quantities of waste wattle wood and spent bark at present have to be disposed of by burning it is worth while considering the manurial value of the ash left after the material has been burnt.

In 1919 the Imperial Institute investigated the ash produced by burning black wattle wood on the locomotives of the Uganda Railway as a possible source of potash (this BULLETIN, 1919, 17, 281). It was found that the total quantity of potash present amounted to 7.76 per cent. (expressed as  $K_2O$ ), 6.98 per cent. being soluble in water. By extracting the ash with water and evaporating the solution to dryness it was estimated that nearly 300 lb. of "crude potashes" could be prepared from one ton of ash. The ash also contained 2.11 per cent. of phosphates (expressed as  $P_2O_5$ ).

In a publication issued by the South African Department of Agriculture it is pointed out that the composition of the ash of wattle wood varies with the maturity of the wood, that of young trees and branches being richer in potash and phosphoric acid, whilst the mature wood contains more lime. The range in composition of the ash may be taken to be as follows :

Potash ( $K_2O$ )	.	.	.	.	.	15-25 per cent.
Phosphoric acid ( $P_2O_5$ ),	.	.	.	.	.	1.5-2.5 " "
Lime ( $CaO$ )	.	.	.	.	.	20-30 " "

The potash content of 100 lb. of wattle wood ash is thus approximately equivalent to 30 lb. of muriate of potash. The quantity of phosphoric acid present is almost negligible from a manurial point of view. Owing to the lime and potash being principally in the form of carbonate, the ash is particularly suitable for applying

to sour soils, but for the same reason it is less suited to alkaline soils.

The ash of the spent bark is much poorer in potash and also contains less phosphoric acid than the wood ash, the proportion being approximately 3 per cent. and 1 per cent. respectively. An application of 1,000 lb. of bark ash per acre would be equivalent to about 50 lb. each of muriate of potash and superphosphate.

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## NOTES

**Flax Industry in Oregon.**—The Department of Overseas Trade has kindly furnished the following extract from the Portland *Oregonian* of January 6, 1929, which has been received by the Department from the Commercial Secretary at Washington:

"The flax industry in western Oregon has been of slow growth, and for a number of years was confined to making linseed oil. Through the efforts of Mrs. William P. Lord and other pioneer women of this state, the study of flax for fiber and tow and making linen products was taken up, and the processes and industries connected with making commercial products were studied and made the subject of experiments by the college of agriculture and the state authorities. For about ten years the flax and linen products industry have had the encouragement of two state administrations. The land owners on the Willamette valley covering an area of about six counties have been willing to take up growing fiber flax as a regular farm crop as they were convinced it was a profitable thing to do.

"The story of founding a new industry suitable to a commonwealth, enlisting investments of capital so far approaching a total of \$2,000,000, involving the introduction of new machinery, new implements and new markets, contributing to industrial employment on the farms and in the cities, establishing machine shops and improving and inventing new machinery, is the working out of a new chapter in industrial history. Taking all in all, it is the biggest thing ahead of the people of Oregon. The determination of Governor Patterson to apply the principles of good business, which includes good financing and good industrial management, is a matter of great importance to the people of Oregon. Machinery and equipment had to be procured to harvest the flax crop. Pulling flax by hand was found impracticable in Oregon.

Flax pulling machines were brought into Oregon and improved, and later new ones built by the flax industry under royalties. Machines for pulling flax were originally brought into Oregon from Canada, costing \$2,250 and freight. They are now made in the plant of the State Flax Industry, and sold new to the farmers for \$1,250 each. Forty-five flax pullers built new or rebuilt will be at work in the harvest fields of Oregon next year.

" Under the direction of the state board of control, composed of Governor Patterson, Secretary of State Hoss and State Treasurer Kay, and only to get the industry started, seed was sold to enough land owners willing to grow 3,200 acres of flax in 1928, and the same produced 4,000 tons of flax straw, which is now stored in large sheds at the plant near Salem, and is being worked up into fiber and the accompanying by-products with the most modern and improved machinery. Arrangements are completed for increasing the crop of 1929 by about 50 per cent., and advancing the same into the fiber stage, which finds ready sale at the twine and linen mills that have been erected at Salem with private capital.

" Farmers of Marion and the surrounding counties are planning to develop this industry, so that in about five years they will have 10,000 acres of flax under cultivation, producing an average of  $1\frac{3}{4}$  tons fiber flax to the acre, or at the end of that period a crop ready to harvest of 17,500 tons fiber flax straw. These estimates are vouched for as correct and conservative by officials in a position to know, Henry W. Myers, superintendent of flax industry, and W. B. Bartram, manager of the Salem Line Mills company.

" Superintendent Meyers says :

" The flax industry is now contracting for the 1929 flax crop and pays as high as \$40 a ton for flax straw that grades No. 1. This grade of flax ordinarily produces about three tons of flax straw to the acre. There is also the problem of fertilisers, cultivation of the soil, ridding the land of weeds and all the difference between good and poor farming. Father Joseph of the St. Benedict's Abbey of Mount Angel cleaned a field of 30 acres from noxious weeds and got \$3,150 for a good crop of flax straw. He had almost given up the land as being too foul, but changed his mind and had the weeds pulled by hand with the above results. The people of Oregon are realising the prospects of a new industry and will add a national supply of the most ancient textile known in history to the woollens and cottons and even supply material to make fire hose and rubber tyres.

" The flax industry developed in the state of Oregon will at the end of the five-year period be producing cash values amounting to several million dollars as a result of the industries founded at Salem and vicinity. The manufacturing plants that take the farm crop of flax and convert it into marketable commercial line products represent investments of \$1,500,000, largely subscribed by the people of Salem.

" The present status of the flax industry shows the 1928 crop, 4,000 tons of fiber straw, being processed and converted into fiber for linen commercial products. At 220 pounds of long fiber from a ton of straw, there will be 880,000 pounds of fiber from the 1928 crop, which finds ready sale at the Salem linen factories, making a total market value of \$220,000. The values of fiber vary on grade ranging from 21 cents to 30 cents per pound at Salem. The by-products from the 4,000 tons will yield \$85,000 in value. These are made up of flax-seed, spinning tow and stock food. Employing similar figures, when the crop reaches 10,000 acres in 1931, 17,500 tons, the fiber would be worth \$1,300,000, including the value of by-products. The by-products of manufacturing fiber flax with present machinery have reduced the net yield from 'tow' to 3 per cent. of the fiber. In other words, improved machinery produces more fiber with less tow. The 4,000 tons of flax straw will yield about 240,000 pounds of tow worth 10 cents per pound and \$10,000 worth of stock food. The straw yields  $5\frac{3}{4}$  bushels of seed to the ton of straw, worth \$2.25 a bushel at the oil mills to-day.

" Manager Bartram of the Oregon Linen Mills, a private corporation erected by Salem people, says :

" The Miles Linen company is a going concern on a paying basis. The Oregon Linen Mills is also operating on a paying basis, manufacturing linen yarns and later, with machinery already installed, will be weaving linen crashes and towelling. The scutched tow from the new fiber machine is converted into low-count yarns to make crashes, towelling and sack twines. These tow yarns are used in conjunction with warp yarns and a filler. Stock food is made from screened flax bolls and whole light flaxseed, and weed seeds that come over the screens of the seed cleaning machines.

" The Miles Linen company's plant was erected in the fall of 1925, and employs about seventy persons manufacturing salmon-net twine, sack twine and shoe thread from Oregon flax. The size of the plant has been nearly doubled during the present year by adding

a warehouse, stock rooms and additional machinery. The Pacific coast fisheries, after four years trying out on equal terms with the Barbour products from the Atlantic coast, are giving the Oregon flax products the preference. It is a fact that the flax industry has made a success to such an extent that it is probably well established in Oregon and many are of the opinion that a large area of land in the western part of the state of Washington is just as well adapted to growing fiber flax as the state of Oregon.

"There can be little doubt but that fiber flax will become a staple crop for the farmers and one of our largest employers of labour for men and women in the manufacturing lines. The state of Oregon has done the pioneer work on the Pacific coast, and the present state administration has admirably backed up and succeeded the previous administration of the state by employing strictly business methods, coupled with enthusiasm and devotion to the cause of establishing a new industry. Hundreds of thousands of dollars annually are distributed among the farmers and industrial labour at Salem. Who would not say that such a result is very desirable and a great credit to the enterprise of the farmers who have learned to grow fiber flax, and the business men who have learned to work it up in products finding a ready sale, and stimulating other cities to promote the industry?

"The Oregon State college has made a survey and tests of the soil and acreage in the Willamette valley, and reports at least 240,000 acres of land suitable for growing flax for fiber for the linen industry. The fiber is equal to the best that can be produced in almost any part of the world, and said by experts to be equal to the flax grown on the river Lys in the district of Courtrai, Belgium. This conclusion has been arrived at after fifteen years of experimental labour and distribution of the Oregon fiber in the markets of the world. With the present facilities the Willamette valley is unable to supply the demand for Oregon flax and flax products.

"The Willamette river has tributaries extending through 200 miles of western Oregon. These streams contain the necessary bacterial elements required to produce high-grade fiber. For retting the soft snow water from the mountains produces the most perfect results without the use of chemicals. In parts of Europe flax is retted in stagnant pools, producing a lower grade and imperfect fermentation.

"The Pacific Coast Linen Mills at Vancouver, Washington, will be ready for operation about the first

of the year, according to S. R. Hamilton, manager. Delay in the installation of machinery will hold up actual operation until about that time. The plant is said to be one of the largest in the United States, and will furnish a market for flax grown in the state of Washington.

"It has recently been reported that the city of Dallas, in Polk county, Oregon, is to erect a modern flax mill for de-seeding, retting and scutching fiber flax, which will advance the industry to the fiber stage, where it is worth from 20 to 30 cents a pound in the open market. A number of towns in the Willamette valley are now laying the foundation of similar flax plants, and it is expected that in a few years the Willamette valley will be dotted with scutching mills that will be producing sufficient flax to meet all the requirements of the United States, and probably have a surplus for export."

**Regulations for the Export of Flax from Lithuania.—**

The following translation of the regulations relating to the exportation of flax from Lithuania has been received from the Department of Overseas Trade.

*Para. 1.* The following customs duty is fixed for flax exported through the customs houses of Naumiėstis, Virbalis, Pagegiai, Memel, Mazoikiai and Joniskis, subject to compliance with the provisions laid down in paragraphs 2 and 4 of these regulations :

(a) dressed flax and tow containing not more than 15 per cent. of refuse (waste) in proportion to the total weight, duty free.

(b) undressed flax of any kind or description and tow containing more than 15 per cent. of refuse (waste) in proportion to the total weight and flax straw, 20 lits<sup>1</sup> per 100 kgs.

(c) waste, 2 lits per 100 kgs.

*Para. 2.* The customs duty fixed in paragraph 1 shall be applicable to flax which, in addition to the proportion of refuse laid down in paragraph 1, conforms to the following conditions :

(a) the bundle of flax to be exported must be tied either with one twisted band of the same material or with a new flax cord of good quality and not thicker than 1 cm. :

*Remark 1.* For the purpose of preventing the flax from soiling during transportation, a second band of the same material as the first one may be placed on the lower part of the bundle. The first band must, however, be tied in such a way as to secure the bundle.

<sup>1</sup> 1 lit = 5d. (approx.).

*Remark II.* The provision of sub-section (a) is not applicable to dressed flax.

(b) if the bales of flax are tied with twines, the latter must be of flax or tow, of good quality, clean and not thicker than 2 cm.; the total weight of the twines must not exceed 1.5 per cent. of the weight of the bale :

*Remark.* Bales of pressed flax or tow may be tied with wire not thicker than 0.5 cm. instead of twine.

(c) the bales must be provided with a wooden label containing stamped inscriptions ; on one side the words : " Lithuanian flax," the mark showing the quality of the flax, the name of the firm of exporters as registered with the Trade Department or of the trade mark, if such has been registered with that Department in the usual way ; additional marks may if desired by the exporter be shown on the other side of the label.

A second label with similar inscriptions must be packed inside the bale.

*Para. 3.* Flax exported through any other customs houses or not in conformity with the stipulations laid down in paragraphs 2 and 4 is subject to a customs duty of 20 lits per 100 kgs., irrespective of the quality of the flax.

*Para. 4.* The following flax exporters are entitled to avail themselves of the customs duty fixed in paragraph 1 of these regulations :

(a) those who upon supplying information regarding their firm and its organisation, have been registered with the Trade Department ;

(b) those who are in possession of permanent warehouses for the assortment of the flax to be exported, and who employ competent flax sorters.

*Para. 5.* The Trade Department is entrusted with the issue of detailed instructions for the fulfilment of these regulations.

*Para. 6.* These regulations shall come into force as from January 15, 1929 ; the regulations published in *Government Gazette* No. 265, serial number 1715, will cease their validity as from that date.

**Empire Marketing Board. Reports on Experimental Consignments of Empire Produce.**—In October, 1927, a note was sent to Dominion and Colonial Trade Commissioners in London, pointing out that the Empire Marketing Board would be glad to co-operate in any experiments designed to explore the possibilities of an export trade in fruit to the markets of the United Kingdom.

A number of experimental consignments of fruit and other products have since been received by the Board, and reports furnished to the Governments concerned. As many of these reports are, in part at least, of general interest, and might usefully be circulated to oversea Governments, it was decided to issue selected reports from time to time in a series entitled "Reports on Experimental Consignments."

The following Reports in this series have just been issued :

No. 1. Fruit Pulp from Cyprus.

No. 2. Pomelos (Shaddock) from Palestine.

No. 3. Orange Pulp from Cyprus (second consignment).

No. 4. Tomato Purée from Nassau, Bahamas.

No. 5. Potatoes from Palestine.

The Series is in addition to the longer and more general reports which have been issued dealing with fruit investigations and experimental consignments, of which Special Report No. 4, entitled "Report on an Experimental Shipment of Palestine Grapes," is the latest published.

Copies of these reports may be had on application to the Secretary, Empire Marketing Board, 2 Queen Anne's Gate Buildings, London, S.W.1.

**Grapefruit Culture in the British West Indies and British Honduras.**—Under this title the Empire Marketing Board have issued a survey by Professor H. Clark Powell of South Africa, who has been investigating the position and possibilities of grapefruit production in different countries of the Empire. The world's consumption of grapefruit is increasing ; and it would seem that there are very good prospects for the fruit in the West Indies, where natural conditions are more favourable to production at a low cost than in any of the countries at present responsible for the bulk of the world's supply. Jamaica is the principal producing centre in the West Indies, the industry in Trinidad and British Honduras being as yet in its infancy.

Professor Powell gives a considerable amount of information and advice, with particular reference to West Indian conditions, regarding the planting of groves, the selection of buds and root stocks, nursery practice, pests and diseases, and the picking and packing of the fruit. Importance is attached to the question of varieties. For marketing purposes uniformity of product is of great importance, and for this reason it is desirable to devote

attention to the growing of a few thoroughly satisfactory varieties, rather than to produce a large number. The Marsh and Duncan varieties are recommended for planting in the West Indies.

**The World's Production of Oranges.**—A useful statistical survey of the production and consumption of oranges has been issued by the Empire Marketing Board, in the form of a Memorandum entitled *Oranges: World Production and Trade* (H.M. Stationery Office, price 1s.). The four principal producing countries are the United States, Spain, Japan and Italy, which together are responsible for at least three-quarters of the world's production. The greater part of the production of the United States is consumed at home, and Spain is considerably the greatest exporter of oranges, contributing about two-thirds of the total entering world trade. Palestine is increasing in importance as an exporting country. The chief among countries showing smaller exports are the Union of South Africa, Australia, Algeria, Japan, Syria, Cuba, Porto Rico, China and the countries of South America. Among importing countries the United Kingdom is first and Germany second, other important markets being France, Belgium, Holland, Poland, Czechoslovakia, Switzerland, Norway, Sweden, Hungary, Denmark, the Irish Free State and Roumania.

The world's total production of oranges is rapidly increasing and the problem of their disposal is likely to become a pressing one in the near future.

## RECENT RESEARCH ON EMPIRE PRODUCTS

### A Record of Work conducted by Government Technical Departments Overseas

#### AGRICULTURE

##### SOILS AND MANURES

**British Malaya.**—Mr. W. N. C. Belgrave, Plant Physiologist, reports that the soil survey which is being conducted in Malaya has now reached Klang, in the State of Selangor. During the period July 1 to December 31, 1928, 995 samples were taken.

Pot culture experiments with ragi have shown, as was anticipated, a marked phosphorus deficiency in the three inland soil types of Malaya. Green manure turned in gave the best results in connection with a small application of phosphorus. Lime was beneficial only in con-

junction with farmyard manure. These experiments will shortly be extended to the field.

A series of percolation experiments showed a very clear relationship between hydrogen ion concentration of percolate and nitrate content ; the bearing of this observation on the question of pH values of Malayan soils and on nitrification is being considered.

**Leeward Islands.—St. Kitts.**—Mr. R. E. Kelsick, Agricultural Superintendent, reports that work in connection with the effect of additions of sugar cane megass to the soil and the rate of nitrification of fertilisers was continued during the half-year ending January 31, 1929. The laboratory experiments indicate that when applications of megass are made direct to the soil no nitrates are available for the growth of the plant for a very considerable time (11 weeks so far) as a result of increased activities of soil bacteria. A plot of land which was treated with megass is now being examined to ascertain if this result is borne out in the field.

The laboratory nitrification experiments with sulphate of ammonia and fish manure show that these give maximum nitrification between the seventh and ninth weeks when applied to St. Kitts soils.

**Nigeria.**—Mr. W. E. de B. Diamond, Agricultural Chemist, reports that the research work on soil during the past year has been continued on much the same lines as in 1927, and the results obtained have confirmed those previously reported.

The study of the factors affecting nitrification, in field plots under crop, has shown that there is a period of very active nitrification in the spring. Nitrates accumulate very rapidly in the soil, until a maximum is reached about the beginning of May. The amount of the maximum depends on the cultivation and cropping, but maxima of 70 parts per million of nitric nitrogen or over 200 lb. per acre have been recorded on plots on which green manure has been dug in. The amount of nitrogen supplied by the green manure is only about 60 lb. per acre, whilst the amount of organic matter contained in these coarse sandy soils is usually very low. After this period of maximum accumulation the nitrate is rapidly removed from the top nine inches of the soil. Although much of this loss is undoubtedly due to leaching it is possible that some denitrification may take place, whilst the rate of nitrification would also seem to fall to a minimum : the exact cause or causes of this loss are now being investigated.

A second period of active nitrate accumulation has also been recorded in the autumn. The time of maximum accumulation during this second period is about the end of August or beginning of September and is related to the increase in rainfall that follows the short dry period that occurs about the end of July and continues to about the middle of August.

Experiments on frequency of cultivation have been continued and have given some very interesting results. The yields on the cultivated plots have been consistently very much higher than those from the uncultivated plots. These increased yields do not appear to be wholly due to the effect of cultivation on nitrification, or conservation of moisture, and further investigations are being carried out to try to elucidate this matter.

## BEVERAGES

### *Coffee*

**British Malaya.**—Mr. B. Bunting, Agriculturist, reports that all varieties of coffee planted at the Government Experimental Plantation, Serdang, are now in bearing; consequently preliminary results of yield will be available shortly. The whole area has been thoroughly pruned and all suckers are systematically removed at intervals of about six weeks.

The variety which has done best to date under Serdang conditions is Uganda No. 1-02.

From the data available it appears that keeping the ground clean-weeded produces the best crop, at least while the bushes are young.

## FODDERS AND FEEDING STUFFS

**Fiji.**—An account of work conducted in Fiji on some of the more common pasture plants found in the Colony has been published by Dr. J. D. Tothill, Superintendent of Agriculture, in the *Agricultural Journal, Fiji* (1928, 1, No. 3, p. 12). The grass that shows up best in the analyses is *Paspalum dilatatum*, which has not hitherto been used to any great extent in the Colony, but which is receiving greater attention at the present time. The results of analysis gave 2.51 per cent. of protein, 11.02 per cent. of carbohydrate, 0.36 per cent. of fat and 76.81 per cent. of water. The sensitive plant, *Mimosa pudica*, which is largely used as a pasture plant in the Colony, is particularly rich in proteins and fat, though the carbohydrate content is rather low. An average of the analyses of 3 samples gave 4.4 per cent. of protein, 12.35 per cent. of carbo-

hydrates and 0.71 per cent. of fat. Para grass, *Panicum barbinode*, which is at present the principal grass used by dairymen in the Colony, is quite a useful grass, although the fat content was found to be low.

It is suggested that a feeding mixture suited to many dairy farms in the Colony would be, 50 per cent. green ripe corn, 25 per cent. para (pasture) and 25 per cent. Mimosa (pasture). This mixture is a particularly good one and should produce more butter fat in the winter months than does para grass alone in the wet season.

On farms where Mimosa has not yet been introduced, a fairly satisfactory mixture for the dry months would be, 50 per cent. green ripe corn and 50 per cent. para (pasture).

## FRUITS

### *Brazil Nuts*

**British Malaya.**—Mr. B. Bunting, Agriculturist, reports that an area of approximately five acres of undulating land, comprising a laterite loam, at the Government Experimental Plantation, Serdang, has recently been planted with this crop. This planting represents the second generation of this tree in Malaya.

### *Citrus*

**Leeward Islands.**—*Dominica.*—A report on the activities of the Lime Experiment Station, Dominica, since its formation in April 1913, has been furnished, from which the following particulars are taken.

The total expenditure on the Station up to date amounts to £4,513 1s. 10d. and the receipts to £6,949 9s. 4½d. Supervision, always a considerable charge, has cost nothing in this instance, the work being done by the Agricultural Officers. A fair amount of assistance has also been given by the agricultural pupils who have been under training during recent years. These pupils were from time to time engaged in sowing green dressings, applying manures, pruning the trees and other work of a light character.

The figure of expenditure given above not only comprises the maintenance of the present bearing areas of limes, including the gathering, but also covers the cost of upkeep of about five acres of young lime cultivation, eight acres of young coconuts and a further area of three acres consisting of grapefruit, camphor, avocado pears, etc.

During the fifteen years of its existence the Experiment Station, so far as the disposal of the crop is concerned, has been in the position of a small grower ; that is, the ripe and

green limes have had to be sold in the open market at the current ruling prices.

In the season 1927-28 the Experiment Station crop was 2,239 barrels of ripe limes and 20 barrels of green limes, most of which were sold in the local market and realised the sum of £1,018 13s. 2½d. The total crop for the year was 2,259 barrels of fruit, a slight decrease on that of the previous year.

*Main Manurial Experiments.*—The main manurial experiments now carried on consist of five plots three times repeated, two series with young limes and one series with old limes. They are as follows :

- A. Control manure of nitrogen, phosphates and potash.
- B. Control. No manure.
- C. Mulch of grass, 5 tons per acre.
- D. Nitrogen and phosphates.
- E. Nitrogen and potash.

In each case the nitrogen was originally applied in the form of Swift's manure (6 per cent. ammonia) at the rate of 4 cwt. per acre, but for a period of three years this manure could not be obtained and the equivalent in the form of cotton seed meal was applied instead. During the past three years dried blood (14 per cent. ammonia) has been used.

The phosphate requirements of the plots are furnished in the form of basic slag, applied at the rate of 4 cwt. per acre and the potash by sulphate of potash at the rate of 1½ cwt. per acre. During 1920-21 neither of these manures could be obtained and the falling away of the crop during 1921-22 is in some measure due to the lack of these fertilisers. During recent years sulphate of potash was again available and, as basic slag could not be obtained, 16 per cent. acid phosphate was used in its place.

The mulch applied is mainly in the form of lemon grass supplemented by leaves and young shoots of *Gliricidia maculata*. Both forms of mulch are especially grown on what would otherwise be waste ground in the vicinity of the plots. This system of utilising odd corners, steep hillsides, and the banks of streams for growing material for application to cultivated areas is strongly recommended in Dominica.

In perusing the plot returns for the past year, allowance must be made for the unequal effect on the different plots of the severe storm of July 1926 and also an outbreak of red root disease affecting about 100 trees.

The yields of these plots in barrels of fruit, during the period 1917-18 to 1927-28, are given on page 196.

# RECENT RESEARCH ON EMPIRE PRODUCTS 195

## ELEVEN YEARS' RESULTS OF MANURIAL EXPERIMENTS WITH LIMES

### ORIGINAL SERIES

*Trees planted July, 1913*

Year.	Size of plots.	A. Complete manure. 1.		B. Control. 2.		C. Mulch. 3.		D. Nitrogen and phosphates. 4.		E. Nitrogen and potash. 5.	
		Per plot.	Per acre.	Per plot.	Per acre.	Per plot.	Per acre.	Per plot.	Per acre.	Per plot.	Per acre.
1917-18	$\frac{1}{4}$ acre	15 $\frac{3}{4}$	63	14	56	23 $\frac{3}{4}$	95	23 $\frac{3}{4}$	95	7 $\frac{3}{4}$	31
1918-19	"	60	240	45 $\frac{3}{4}$	183	71 $\frac{3}{4}$	287	58 $\frac{1}{2}$	234	34 $\frac{3}{4}$	139
1919-20	"	85	340	89 $\frac{1}{2}$	358	99 $\frac{1}{2}$	398	88 $\frac{1}{2}$	354	60 $\frac{1}{2}$	242
1920-21 <sup>1</sup>	"	118 $\frac{3}{4}$	475	109 $\frac{1}{2}$	437	130 $\frac{1}{2}$	522	117 $\frac{1}{2}$	470	112	448
1921-22	"	95	380	85 $\frac{3}{4}$	343	99	396	85 $\frac{3}{4}$	343	88	344
1922-23	"	88	252	68 $\frac{1}{2}$	274	85 $\frac{1}{2}$	382	81 $\frac{1}{2}$	326	90 $\frac{1}{2}$	362
1923-24 <sup>2</sup>	"	56 $\frac{1}{2}$	225	47 $\frac{1}{2}$	189	69 $\frac{3}{4}$	279	56 $\frac{1}{2}$	226	63	252
1924-25	"	51	204	38	152	53 $\frac{1}{2}$	213	37	148	48 $\frac{3}{4}$	195
1925-26	"	50 $\frac{1}{2}$	201	31 $\frac{1}{2}$	128	50 $\frac{1}{2}$	201	49 $\frac{1}{2}$	197	42 $\frac{3}{4}$	171
1926-27	"	47 $\frac{1}{2}$	190	28 $\frac{1}{2}$	113	49 $\frac{1}{2}$	197	43	172	41 $\frac{1}{2}$	166
1927-28	"	44 $\frac{1}{2}$	178	21 $\frac{1}{2}$	86	47	188	37 $\frac{3}{4}$	151	31 $\frac{1}{2}$	125

### DUPLICATE SERIES

*Trees planted July, 1913*

		6.		7.		8.		9.		10.	
1917-18	$\frac{1}{4}$ acre	6 $\frac{3}{4}$	27	10 $\frac{1}{2}$	41	18	72	6 $\frac{3}{4}$	27	10 $\frac{1}{2}$	43
1918-19	"	34 $\frac{1}{2}$	139	22 $\frac{1}{2}$	90	42 $\frac{1}{2}$	169	30	120	38 $\frac{1}{2}$	154
1919-20	"	57 $\frac{1}{2}$	231	38	152	69 $\frac{1}{2}$	279	60 $\frac{1}{2}$	242	72 $\frac{1}{2}$	290
1920-21 <sup>1</sup>	"	117	468	81 $\frac{1}{2}$	326	115 $\frac{1}{2}$	462	105 $\frac{3}{4}$	423	115 $\frac{1}{4}$	463
1921-22	"	79	316	52 $\frac{1}{2}$	209	85 $\frac{1}{2}$	342	81	324	94	376
1922-23	"	77	308	45	180	80	320	82	328	97	388
1923-24 <sup>2</sup>	"	55 $\frac{1}{2}$	221	35 $\frac{3}{4}$	143	60 $\frac{1}{2}$	242	54	216	70 $\frac{1}{2}$	282
1924-25	"	47	188	29 $\frac{1}{2}$	117	46	184	40 $\frac{1}{2}$	162	56 $\frac{1}{2}$	226
1925-26	"	37 $\frac{3}{4}$	151	21	84	47 $\frac{1}{2}$	190	50 $\frac{1}{2}$	201	55 $\frac{1}{2}$	222
1926-27	"	32 $\frac{1}{2}$	130	20 $\frac{1}{2}$	81	44	176	41 $\frac{1}{2}$	166	48	192
1927-28	"	33 $\frac{1}{2}$	135	13	52	33 $\frac{1}{2}$	133	32 $\frac{3}{4}$	131	48 $\frac{3}{4}$	195

### TRIPPLICATE SERIES

*Old trees planted 1893*

		11.		12.		13.		14.		15.	
1917-18	$\frac{1}{4}$ acre	45	180	29 $\frac{3}{4}$	119	25 $\frac{1}{2}$	102	27 $\frac{1}{2}$	110	22 $\frac{3}{4}$	91
1918-19	"	70	280	32 $\frac{1}{2}$	130	23	92	52 $\frac{1}{2}$	210	34 $\frac{1}{2}$	138
1919-20	"	89 $\frac{3}{4}$	359	48 $\frac{1}{2}$	194	32	128	67 $\frac{1}{2}$	269	50	200
1920-21 <sup>1</sup>	"	85 $\frac{1}{4}$	341	52 $\frac{1}{2}$	210	43 $\frac{3}{4}$	175	97	388	64 $\frac{3}{4}$	259
1921-22	"	74	296	42 $\frac{1}{2}$	170	40	160	79	316	73 $\frac{1}{2}$	295
1922-23	"	69	276	34	136	37	148	86	344	70	280
1923-24 <sup>2</sup>	"	54 $\frac{1}{2}$	218	26 $\frac{1}{2}$	106	45 $\frac{1}{2}$	181	61 $\frac{1}{2}$	245	56 $\frac{1}{2}$	225
1924-25	"	35 $\frac{1}{2}$	141	21	84	35	140	48 $\frac{1}{2}$	191	43	182
1925-26	"	40 $\frac{1}{2}$	161	24 $\frac{1}{2}$	98	36	144	38 $\frac{3}{4}$	155	43	182
1926-27	"	39	156	19	76	42	168	52 $\frac{1}{2}$	209	48 $\frac{1}{2}$	194
1927-28	"	37 $\frac{3}{4}$	151	18 $\frac{1}{2}$	75	34	136	38	152	46 $\frac{1}{2}$	186

<sup>1</sup> No phosphates applied that year.

<sup>2</sup> First complete year under "Withertip" conditions.

The ten plots of young limes which cover an area of  $2\frac{1}{2}$  acres were planted in July 1913 and were therefore at the end of March 1927 thirteen years and nine months old from the time of being placed out in the fields. The crop returns during this period were as follows :

1917-18	5th year	.	.	.	137 $\frac{1}{2}$	barrels or	55	barrels per acre.
1918-19	6th "	.	.	.	438 $\frac{1}{2}$	"	175	" " "
1919-20	7th "	.	.	.	721 $\frac{1}{2}$	"	288	" " "
1920-21 <sup>1</sup>	8th "	.	.	.	1,124	"	450	" " "
1921-22	9th "	.	.	.	844 $\frac{1}{2}$	"	338	" " "
1922-23	10th "	.	.	.	805	"	322	" " "
1923-24 <sup>2</sup>	11th "	.	.	.	568 $\frac{3}{4}$	"	227	" " "
1924-25	12th "	.	.	.	447 $\frac{1}{4}$	"	179	" " "
1925-26	13th "	.	.	.	436	"	174	" " "
1926-27	14th "	.	.	.	396	"	158	" " "
1927-28	15th "	.	.	.	343 $\frac{1}{4}$	"	137	" " "

A better idea of the effects of the various manures and cultural measures carried on may be gained from the table below, in which plots, each receiving identical treatment in the three series of experiments, are grouped together. This table shows at a glance the actual yield per three plots of a kind grouped together, the calculated yield per acre and the increase or decrease per acre per annum compared with the previous year.

### 3 COMPLETE MANURE PLOTS ( $\frac{1}{4}$ ACRE EACH)

Year.	Area.	Yield in barrels per $\frac{1}{4}$ acre.	Calculated yield in barrels per acre.	Increase or decrease per acre compared with previous year.
1917-18	. . $\frac{1}{4}$ acre	67 $\frac{1}{2}$	90	
1918-19	. . "	164 $\frac{1}{4}$	219 $\frac{3}{4}$	+ 129 $\frac{3}{4}$
1919-20	. . "	232 $\frac{1}{2}$	310	+ 90 $\frac{1}{2}$
1920-21 <sup>1</sup>	. . "	321	428	+ 118
1921-22	. . "	248	330 $\frac{3}{4}$	- 97 $\frac{1}{2}$
1922-23	. . "	234	312	+ 18
1923-24 <sup>2</sup>	. . "	166 $\frac{1}{2}$	222	- 90
1924-25	. . "	133 $\frac{1}{4}$	177	- 44 $\frac{3}{4}$
1925-26	. . "	128 $\frac{1}{4}$	171	- 6 $\frac{3}{4}$
1926-27	. . "	119	158 $\frac{3}{4}$	- 12 $\frac{1}{2}$
1927-28	. . "	115 $\frac{1}{4}$	154	- 3 $\frac{1}{4}$

1,930 total yield for 11 years.

### 3 CONTROL PLOTS ( $\frac{1}{4}$ ACRE EACH)

1917-18	. . $\frac{1}{4}$ acre	54	72	
1918-19	. . "	100 $\frac{1}{4}$	134 $\frac{1}{4}$	+ 62 $\frac{1}{4}$
1919-20	. . "	176	234 $\frac{3}{4}$	+ 100 $\frac{3}{4}$
1920-21 <sup>1</sup>	. . "	243 $\frac{3}{4}$	324 $\frac{1}{4}$	+ 89 $\frac{3}{4}$
1921-22	. . "	180 $\frac{1}{4}$	240 $\frac{3}{4}$	- 84
1922-23	. . "	147	196	- 44 $\frac{1}{2}$
1923-24 <sup>2</sup>	. . "	109 $\frac{1}{2}$	146	- 50
1924-25	. . "	88 $\frac{1}{2}$	118	- 28
1925-26	. . "	77	102 $\frac{3}{4}$	- 15 $\frac{1}{4}$
1926-27	. . "	94 $\frac{1}{2}$	126	+ 23 $\frac{1}{2}$
1927-28	. . "	53 $\frac{1}{4}$	71	- 41 $\frac{1}{4}$

1,324 total yield for 11 years.

<sup>1</sup> No phosphates or potash applied that year.

<sup>2</sup> First complete year under "Withertip" conditions.

3 MULCH PLOTS ( $\frac{1}{4}$  ACRE EACH)

Year.	Area.	Yield in barrels per $\frac{1}{4}$ acre.	Calculated yield in barrels per acre.	Increase or decrease per acre compared with previous year.
1917-18 . . .	$\frac{1}{4}$ acre	67 $\frac{1}{2}$	80 $\frac{3}{4}$	
1918-19 . . .	"	138	184	+ 94 $\frac{1}{2}$
1919-20 . . .	"	201 $\frac{1}{2}$	268 $\frac{1}{2}$	+ 84 $\frac{1}{2}$
1920-21 <sup>1</sup> . . .	"	289 $\frac{3}{4}$	386	+ 117 $\frac{3}{4}$
1921-22 . . .	"	224 $\frac{1}{2}$	299 $\frac{1}{2}$	+ 86 $\frac{1}{2}$
1922-23 . . .	"	212	282 $\frac{3}{4}$	- 16 $\frac{3}{4}$
1923-24 <sup>2</sup> . . .	"	175 $\frac{3}{4}$	234 $\frac{1}{2}$	- 48 $\frac{1}{2}$
1924-25 . . .	"	135	180	- 54
1925-26 . . .	"	133 $\frac{3}{4}$	178 $\frac{1}{2}$	- 1 $\frac{1}{2}$
1926-27 . . .	"	135 $\frac{1}{2}$	180 $\frac{1}{2}$	+ 2
1927-28 . . .	"	114 $\frac{1}{2}$	152 $\frac{1}{2}$	- 21

1,826 $\frac{3}{4}$  total yield for 11 years.

3 NITROGEN AND PHOSPHATE PLOTS ( $\frac{1}{4}$  ACRE EACH)

1917-18 . . .	$\frac{1}{4}$ acre	64 $\frac{1}{2}$	86 $\frac{1}{2}$	
1918-19 . . .	"	141	188	+ 101
1919-20 . . .	"	216 $\frac{1}{2}$	288 $\frac{1}{2}$	+ 100 $\frac{1}{2}$
1920-21 <sup>1</sup> . . .	"	320 $\frac{1}{2}$	427	+ 138 $\frac{1}{2}$
1921-22 . . .	"	240 $\frac{1}{2}$	320 $\frac{3}{4}$	- 106 $\frac{1}{2}$
1922-23 . . .	"	250	333 $\frac{1}{2}$	+ 12 $\frac{1}{2}$
1923-24 <sup>2</sup> . . .	"	171 $\frac{3}{4}$	299	- 104 $\frac{1}{2}$
1924-25 . . .	"	126	168	- 61
1925-26 . . .	"	138 $\frac{1}{2}$	184 $\frac{1}{2}$	+ 16 $\frac{1}{2}$
1926-27 . . .	"	136 $\frac{1}{2}$	182 $\frac{1}{2}$	- 2
1927-28 . . .	"	108 $\frac{1}{2}$	144 $\frac{3}{4}$	- 28 $\frac{1}{2}$

1,914 total yield for 11 years.

3 NITROGEN AND POTASH PLOTS ( $\frac{1}{4}$  ACRE EACH)

1917-18 . . .	$\frac{1}{4}$ acre	41 $\frac{1}{2}$	55	
1918-19 . . .	"	107 $\frac{1}{2}$	134 $\frac{1}{2}$	+ 88 $\frac{1}{2}$
1919-20 . . .	"	183	244	+ 100 $\frac{1}{2}$
1920-21 <sup>1</sup> . . .	"	292 $\frac{1}{2}$	390	+ 146
1921-22 . . .	"	253 $\frac{3}{4}$	338 $\frac{1}{2}$	- 51 $\frac{1}{2}$
1922-23 . . .	"	257	342 $\frac{1}{2}$	+ 3 $\frac{1}{2}$
1923-24 <sup>2</sup> . . .	"	190	253 $\frac{1}{2}$	- 89 $\frac{1}{2}$
1924-25 . . .	"	148	197	- 56
1925-26 . . .	"	141 $\frac{1}{2}$	188 $\frac{1}{2}$	- 8 $\frac{3}{4}$
1926-27 . . .	"	138	184	- 4 $\frac{1}{2}$
1927-28 . . .	"	126 $\frac{1}{2}$	168 $\frac{3}{4}$	- 12 $\frac{1}{2}$

1,879 total yield for 11 years.

<sup>1</sup> No phosphates or potash applied that year.

<sup>2</sup> First complete year under "Withertip" conditions.

The falling off in yields on the above-mentioned plots was entirely due to (1) the presence of the Withertip disease of limes which was first noticed in the Experiment Station in July 1922; (2) the storm of July 22, 1926; and (3) an outbreak of red root disease.

Judging by Dominica standards all the plots, including those receiving no manure, have done well. In the latter instance the influence of good cultural measures, apart from the application of manures, must be evident to all who study the table of crop returns.

The mulched plots, although not giving the highest return, are of special interest to lime growers. As is well known this material is without the forcing effect of concentrated fertilisers, but it is cumulative in its effect. It is practically certain that the standard of health of the lime tree is higher in the mulched than in any of the plots receiving concentrated manure only. This material which is so abundant in the island should be chiefly used by cultivators.

*Other Manurial Experiments.*—Both seedling and spineless limes budded on sour orange stock and ordinary seedlings have been under experiment since 1914 and occupy an acre of land.

The acre is divided up into  $\frac{1}{4}$ -acre plots: two plots of common limes budded on sour orange stocks; one plot of spineless limes on the same kinds of stock; and one plot of ordinary seedling limes for comparison.

During 1917-18 and 1918-19 the trees in each plot received a small dressing of organic nitrogen at the rate of 4 cwt. per acre. During the first three years of their existence No. 1 budded plot (see table below) was grown with Tephrosia as a green dressing, whilst No. 2 budded plot was grown in the usual way with weeds and grass which was occasionally weeded. The spineless limes had green dressings of horse beans and the seedling limes were clean-weeded. Early in 1919-20 each plot received a complete manure of nitrogen, phosphates and potash. It is intended to maintain this series as complete manure plots. The crop yields of the four plots since fruiting were as follows:

ELEVEN YEARS' RESULTS OF EXPERIMENTS CONDUCTED WITH SPINELESS AND COMMON LIMES BUDDED ON SOUR ORANGE STOCKS AND WITH COMMON SEEDLING LIMES.

*Planted July 1914*

*Spineless limes budded on sour orange stocks*

Year.	Size of plot.	Actual yield in barrels per plot.	Calculated yield in barrels per acre,
1917-18 . . . .	$\frac{1}{4}$ acre	6 $\frac{1}{2}$	26
1918-19 . . . .	"	18 $\frac{1}{2}$	73
1919-20 . . . .	"	34	136
1920-21 <sup>1</sup> . . . .	"	46	184
1921-22 . . . .	"	45 $\frac{1}{2}$	182
1922-23 . . . .	"	62	248
1923-24 <sup>2</sup> . . . .	"	26	104
1924-25 . . . .	"	24 $\frac{3}{4}$	98 $\frac{3}{4}$
1925-26 . . . .	"	29 $\frac{1}{2}$	117
1926-27 . . . .	"	16 $\frac{1}{2}$	66
1927-28 . . . .	"	23 $\frac{3}{4}$	95

<sup>1</sup> No phosphates or potash applied that year,

<sup>2</sup> First complete year under "Withertip" conditions.

*Common limes budded on sour orange stocks (No. 1)*

Year.	Size of plot.	Actual yield in barrels per plot.	Calculated yield in barrels per acre.
1917-18 . . . .	$\frac{1}{4}$ acre	8	32
1918-19 . . . .	"	$34\frac{3}{4}$	139
1919-20 . . . .	"	$39\frac{3}{4}$	159
1920-21 <sup>1</sup> . . . .	"	$98\frac{1}{2}$	394
1921-22 . . . .	"	$91\frac{3}{4}$	367
1922-23 . . . .	"	132	528
1923-24 <sup>2</sup> . . . .	"	59	236
1924-25 . . . .	"	$59\frac{3}{4}$	$238\frac{3}{4}$
1925-26 . . . .	"	$68\frac{1}{2}$	273
1926-27 . . . .	"	$48\frac{1}{2}$	194
1927-28 . . . .	"	$50\frac{1}{2}$	204

*Common limes budded on sour orange stocks (No. 2)*

1917-18 . . . .	$\frac{1}{4}$ acre	6	24
1918-19 . . . .	"	$13\frac{3}{4}$	55
1919-20 . . . .	"	$31\frac{1}{2}$	125
1920-21 <sup>1</sup> . . . .	"	86	344
1921-22 . . . .	"	$73\frac{3}{4}$	295
1922-23 . . . .	"	121	484
1923-24 <sup>2</sup> . . . .	"	$65\frac{1}{2}$	261
1924-25 . . . .	"	$67\frac{1}{2}$	269
1925-26 . . . .	"	76	304
1926-27 . . . .	"	$57\frac{1}{2}$	229
1927-28 . . . .	"	56	224

*Common seedling limes*

1917-18 . . . .	$\frac{1}{4}$ acre	nil	nil
1918-19 . . . .	"	$16\frac{3}{4}$	67
1919-20 . . . .	"	$22\frac{3}{4}$	91
1920-21 <sup>1</sup> . . . .	"	61	244
1921-22 . . . .	"	58	232
1922-23 . . . .	"	$64\frac{1}{2}$	258
1923-24 <sup>2</sup> . . . .	"	$55\frac{1}{2}$	223
1924-25 . . . .	"	$50\frac{1}{2}$	201
1925-26 . . . .	"	$42\frac{3}{4}$	169
1926-27 . . . .	"	40	160
1927-28 . . . .	"	$34\frac{1}{2}$	138

<sup>1</sup> No phosphates or potash applied that year.<sup>2</sup> First complete year under "Withertip" conditions.

Attention must again be called to the relatively high yield of the West Indian limes budded on sour orange stocks. These plots are situated in that part of the station most affected by withertip, despite which they persistently give the highest returns. Compared with seedling limes they make a stronger and quicker growth, are of better habit and not so susceptible to dieback and root troubles. The strong rooting quality of this stock was strikingly demonstrated when during last year's storm not a single tree was blown over or uprooted. This alone should vindicate its right to be regarded as the stock for the West Indian lime on suitable soils.

*Recently started manurial experiment plots.*—Three new series each consisting of three plots were started early in 1921. The treatment given in the first series is repeated

in the other two. The plots are numbered 16 to 24. The treatment is as follows :

*Series 1.*

Plot 16.—Ready mixed complete fertiliser (8 per cent. nitrogen and 10 per cent. phosphates and 4 per cent. potash) at the rate of 500 lb. per acre. (with mulch— $2\frac{1}{2}$  tons per acre).

Plot 17.—Control. (No fertiliser or mulch.)

Plot 18.—Ready mixed complete fertiliser (8 per cent. nitrogen, 10 per cent. phosphates and 4 per cent. potash) at the rate of 1,000 lb. per acre (with mulch— $2\frac{1}{2}$  tons per acre).

The following tables show the returns for the six years since the commencement of the experiments—the yields being expressed in barrels.

SERIES I

Year.	A. Complete manure. (500 lb. mixed fertiliser per acre.) 16.		B. Control. (No manure.) 17.		C. Complete manure. (1,000 lb. mixed fertiliser per acre.) 18.	
	<i>Per plot.</i>		<i>Per plot.</i>		<i>Per plot.</i>	
	<i>Per acre.</i>		<i>Per acre.</i>		<i>Per acre.</i>	
1921-22 . . .	17	60 $\frac{1}{2}$	10	30	20	68
1922-23 . . .	46	164	28 $\frac{1}{2}$	85	65 $\frac{1}{2}$	225 $\frac{1}{2}$
1923-24 . . .	50	197 $\frac{1}{2}$	36 $\frac{1}{2}$	110 $\frac{1}{2}$	64 $\frac{3}{4}$	223
1924-25 . . .	55 $\frac{1}{2}$	199	46 $\frac{3}{4}$	141 $\frac{1}{2}$	66 $\frac{1}{4}$	228
1925-26 . . .	51	182 $\frac{1}{2}$	32 $\frac{3}{4}$	99	56	193
1926-27 . . .	51	182 $\frac{1}{2}$	28	84	58 $\frac{1}{2}$	201
1927-28 . . .	35 $\frac{1}{2}$	124	22 $\frac{1}{2}$	66	41 $\frac{1}{2}$	140 $\frac{1}{4}$

SERIES II

	D. 19.		E. 20.		F. 21.	
	<i>Per plot.</i>		<i>Per plot.</i>		<i>Per plot.</i>	
	<i>Per acre.</i>		<i>Per acre.</i>		<i>Per acre.</i>	
1921-22 . . .	6 $\frac{1}{2}$	23	8 $\frac{3}{4}$	22	3 $\frac{1}{2}$	10 $\frac{1}{2}$
1922-23 . . .	18 $\frac{1}{4}$	65	31 $\frac{1}{4}$	80	42 $\frac{1}{4}$	128
1923-24 . . .	32	114	54	138 $\frac{1}{2}$	62 $\frac{3}{4}$	190
1924-25 . . .	51 $\frac{1}{2}$	184	57 $\frac{3}{4}$	148	66	200
1925-26 . . .	69 $\frac{1}{2}$	248	44	112 $\frac{3}{4}$	69 $\frac{1}{2}$	210 $\frac{3}{4}$
1926-27 . . .	58	207	47 $\frac{1}{2}$	122	64 $\frac{1}{2}$	194 $\frac{1}{2}$
1927-28 . . .	42	150	36 $\frac{1}{2}$	92 $\frac{1}{2}$	60 $\frac{1}{4}$	180

SERIES III

	G. 22.		H. 23.		I. 24.	
	<i>Per plot.</i>		<i>Per plot.</i>		<i>Per plot.</i>	
	<i>Per acre.</i>		<i>Per acre.</i>		<i>Per acre.</i>	
1921-22 <sup>1</sup> . . .	36 $\frac{1}{2}$	101 $\frac{1}{2}$	31	91	45 $\frac{3}{4}$	147 $\frac{1}{2}$
1922-23 . . .	23 $\frac{1}{2}$	65	21 $\frac{3}{4}$	64	22 $\frac{3}{4}$	73
1923-24 . . .	22 $\frac{3}{4}$	63	20 $\frac{3}{4}$	61	22 $\frac{3}{4}$	73
1924-25 . . .	29 $\frac{1}{4}$	81	20 $\frac{3}{4}$	60	25	80 $\frac{1}{2}$
1925-26 . . .	35	97 $\frac{1}{2}$	21	61 $\frac{3}{4}$	32	103
1926-27 . . .	38 $\frac{1}{2}$	107	22 $\frac{1}{4}$	64 $\frac{1}{4}$	31 $\frac{1}{2}$	101 $\frac{1}{2}$
1927-28 . . .	32	87 $\frac{1}{2}$	23	67	30 $\frac{3}{4}$	96 $\frac{3}{4}$

<sup>1</sup> Higher returns due to some seedling limes which had not been removed from amongst the budded plants.

The areas of all the above plots are slightly over  $\frac{1}{2}$  of acre each, therefore the value in barrels per acre has been given to the nearest fraction.

*Lime varieties.*—Marked interest has been taken by one or two planters in Bears seedless lime, Tahiti lime, Woglum lime and *Citrus aurantifolia* lime, and in consequence a lively demand is being made for these varieties budded on the sour-orange stock in order that they may be given a field trial in wet districts, where withertip is very virulent. From the Department's plots little has been learned beyond that reported in last year's report, nor is there likely to be until the trees bear sufficient fruit to enable commercial tests to be made with the juice and oil. The juice of Bears seedless, Tahiti and Woglum limes has a flavour closely resembling that of the West Indian lime; the oil from these limes possesses an aroma also similar and the high acid content of the juice points undoubtedly to the suitability of the juice for concentrating. These facts certainly warrant these particular varieties being experimented with on a field scale. At the moment, however, none of the varieties can be recommended for extensive planting, as the experiments are not nearly complete; it has yet to be determined whether the juice and oil will be acceptable to the trade, and also whether such varieties will thrive under local conditions and bear sufficient crops to warrant their cultivation as an economic proposition. *Citrus aurantifolia* invited interest in view of its heavy bearing quality and the high acid content of the juice. Judging from its behaviour in the trial plots, hopes for it in Dominica could not be entertained, as the juice content of the fruit was low and the plants not of a very robust habit. The same view has to be recorded of all plants of this variety growing on the lower lands near the sea. On the other hand, when grown at an altitude of 500 feet or more, the tree presents a happier appearance and the fruits are well filled with juice.

A great variability in shape and size of fruit has also been noted. Thanks to the interest of Mr. S. L. V. Green, most of these varieties have been planted on a field scale on his estate at Sherwood, situated in the interior at an altitude of about 800 feet. All are growing remarkably well and appear to be better suited there than on the drier lands of the Experiment Station.

Other varieties under trial do not warrant any particular mention at present; most of them, particularly the many hybrids raised by the Department, are too young to comment on at the moment.

Five acres of land have been acquired by the Depart-

ment on Copt Hall estate, situated in the Roseau valley and well in the withertip area, and this land will be utilised for stock trials, nursery work and for trying out varieties and hybrids recently introduced or raised.

Fruits obtained from the following varieties were forwarded to the Government Laboratory, Antigua, in the hope that sufficient oil might be extracted to afford an analytical comparison with the essential oil of the West Indian lime: West Indian Woglums lime, Bears seedless, Tahiti, Kusai, Rangpur, *Citrus aurantifolia* and Woglums lemon. Unfortunately a report was received to the effect that sufficient essential oil could not be extracted from the few fruits available for chemical analysis or for the determination of yield. Extracts of the peels with silent spirit were made and the oils classified as far as possible by their aromas. The Assistant Government Chemist states that a comparison of the alcoholic extracts allows a classification on the basis of aromas of the expressed oils which is not necessarily the identical classification that would be made based on the oils obtained by distillation. These extracts have been forwarded to the Imperial Institute, and it is hoped that further information will be obtained for making, at any rate, a preliminary classification.

*Citrus introductions.*—A quantity of seed of a citrus sp. was received from the Economic Botanist, Nagpur, India. It possesses the local name of "Kagsi Nimbu" and despite the long journey has germinated well.

One hundred and twenty-two budded plants, progenies of a cross between the West Indian lime and *Citrus aurantifolia*, were received from the Department of Agriculture, Trinidad. These plants were propagated from six plants, the result of the cross. Some have been planted out in the Department's experimental grounds and the remainder distributed for trial to planters.

Budwood and cuttings of the Meyer Chinese lemon were received from the Bureau of Agriculture, Porto Rico. From this material six budded plants have resulted. Budwood of the following citrus varieties were also received from Porto Rico, but owing to their dried-up condition on arrival, the attempts made to propagate them proved unsuccessful. Lemon varieties: Ponderosa, Sicilian, Pumelo, Siamelo Pumelo, Satsumelo, Tengelo (Sansom), Eustis Limequat, Limequat (S.D.L.), Orangelo (Stokes), Lemonine. Seeds of lime from Solomon Islands were received from Dr. Carment.

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Mr. A. E. Collens, Government Chemist and Superintendent of Agriculture, in a summary report of investi-

gational work carried out in the Leeward Islands during the period July to December 1928, states that the Dominica Agricultural Department has come to the conclusion that in view of the prevalence of red root disease the planting of seedling limes should be discontinued and that all future plantings should be with limes budded on sour-orange stocks.

## ROOT CROPS

### *Cassava*

**British Malaya.**—Mr. B. Bunting, Agriculturist, reports that an area of six acres has been planted at the Government Experimental Plantation with twenty-two  $\frac{1}{4}$  acre plots of each of the nine varieties of cassava, well established here, to compare the yields.

One hundred and fifty cuttings of each of the nine varieties have been planted for the Agricultural Chemist to study the moisture and carbohydrate content at various ages.

In connection with the investigation on tapioca, the Acting Agricultural Chemist has analysed sixty-six samples of plant materials from the Government Experimental Plantation, Serdang, and estates in Johore.

Further experiments and analyses have also been carried out regarding the efficiency of the process at present used in factories in Malaya.

### *Yams*

**Nigeria.**—Mr. O. B. Lean, Entomologist, reports that the study of the yam beetle (*Heteroligus claudius*, Klüg) was continued throughout the period ending December 31, 1929.

As in the previous season, the beetles seemed to disappear in August and September, and in the latter month the ordinary examination of yam stands to a depth of about a foot failed to unearth any beetles. At Wunnune a "beetle infestation determination" was made on July 17, giving 412 beetles per 1,000 heaps. On July 31 no beetles were found. On most farms the beetles seemed to have disappeared somewhat later than this. On October 18 and 20 eight heaps on a "king row" were examined very carefully, the whole heap being removed in each case and the soil excavated to a depth of one to two feet; 23 beetles were found (i.e. 2,875 beetles per 1,000 heaps), mostly at about ground level. Of these beetles, 17 were males, 4 females and 2 were badly damaged. It appeared that the females were migrating for oviposition.

Between October 22 and 25 a 5-acre block of yams (C. 6) was harvested on the Yandev plantation. The number of beetles collected amounted to 47; 26 were of the small variety as yet undetermined, 6 were normal males and 15 normal females. Dissection of some of the females showed eggs nearly ready for laying. Another 5-acre block (C. 7) was harvested on December 3-6 and no beetles were found.

Beetle index determinations as described in Mr. Lean's previous report (this BULLETIN, 1928, 26, 452) were continued throughout and around Tombo West area. These showed very little difference between the infestation within the area and in the surrounding belt of country. Mr. Lean has, however, now discarded this method of determining beetle infestation, as it was found that climatic conditions affected the determinations and, as is shown later, this examination inhibits the growth of the tubers.

He has now come to the conclusion that the only method of determining beetle infestation is by examination of yams harvested at the close of the season and determining the percentage of tubers showing beetle lesions. The Munshis commence harvesting the ordinary types of yams about August, according to their daily needs, and by the end of the rains there are not a great number remaining in the farms, though the plants are left to form small tubers that are used for seed. The water yams are, however, not touched at this time, and these are all collected during the full harvest in December and January. The infestation determinations are therefore based on the analysis of water yams only.

This work is still in progress, as some farmers are late in harvesting. On 39 farms in the trial area the average number of tubers damaged is 13 per cent., as compared with 18 per cent. from 25 farms in the surrounding country.

On 25 farms both water and ordinary yams have been examined. The average percentage of water yams damaged was 13 per cent., as compared with 18 per cent. for the ordinary yams. This agrees with general impressions and with the views of the native farmers. There are at least 20-30 different types of yams grown by the Munshi, but Mr. Lean has been unable to separate these definitely, except into the two main groups of water and ordinary yams.

As mentioned in the previous report (*loc. cit.*, p. 453), an experiment was laid down on the plantation to test the result of planting lemon grass (*Cymbopogon*) with yams. The yams have now been harvested, but the result shows

that no advantage at all is gained by growing the yams beside the lemon grass.

The farm at Wunnune that was found to be very heavily infested lay in a shallow valley about 150 feet from a small stream, the intervening ground being somewhat marshy. On October 23 and 24 a trench, 150 ft. long and 4 ft. deep, was cut from the edge of the farm to the stream, but no yam beetles or larvæ were found. About the same time a thorough search was made in native rubbish heaps, and one elytron of *H. claudius* was found.

In cage experiments, far more deaths of beetles have occurred this season than last during the wet period.

Sixteen adults were bred from eggs laid last season ; some of these were fed on yams and others were unfed, with the following results :

Fed with yam.				Without yam.		
Date of death.	Male.	Female.		Date of death.	Male.	Female.
June 25 . .	—	1		June 18 . .	—	1
Oct. 27 . .	1	—		" 28 . .	—	1
Nov. 8 . .	1	—		July 20 . .	—	1
" 21 . .	1	1		Aug. 10 . .	—	1
" 23 . .	—	—		Sept. 6 . .	1	—
" 24 . .	—	1		Oct. 22 . .	1	—
" 28 . .	—	1				
Dec. 5 . .	—	2				

Two hundred and twenty-one eggs were laid by the beetles fed on yam and none by those unfed.

No alternative foods have yet been found, for either adult or larva.

The life-history has so far been very similar to that worked out last year. The first egg was laid on October 17. The greatest number of eggs were laid during the week ending November 24. A very few eggs are still being laid.

Some of the larvæ are in cages with yams and some without ; there are far more casualties in those without.

None of the small type of beetle has been bred out, and only one of their larvæ was bred to any size.

## SUGAR

### Cane

**Leeward Islands.**—*Antigua.*—Mr. A. E. Collens, Government Chemist and Superintendent of Agriculture, reports that varietal experiments with sugar cane were dis-

continued in Antigua during the year 1928, as it was realised that the lines of experimentation followed were yielding results whose significance could only be determined when the experiments had been carried out over a sufficient number of years to allow of the annual repetitions smoothing out the variations due purely to accidental causes. Plans have been formed for the institution of a series of experiments including sufficient replications to allow of treatment on modern statistical lines, and these experiments will be started as soon as sanction has been given for the increased expenditure required to cover the extra supervision entailed in planting, cultivation and reaping.

## VEGETABLES

### *Tomatoes*

**Leeward Islands.—Montserrat.**—Mr. C. A. Gomez, Curator of the Experiment Station, reports that with a view to the development of an export trade in tomatoes, large nurseries were laid out and planted with tomato varieties in order to ascertain what varieties would suit local conditions of soil and climate, and at the same time prove a success on the Canadian market. Of the varieties grown "Bonny Best" and "Stone" appear best from an all-round point of view. Experiments with tomato shipments to Canada were also conducted. Tomatoes shipped in cold storage were a failure, while those shipped in cool chamber at 60° F., after being in a steamer eight days, reached Canada in perfect condition. This experiment is intended to form the nucleus of an export trade of tomatoes with Canada. Up to the present 1,000 crates of tomatoes have been shipped by the recently organised Peasants' Bureau under the control of the Department of Agriculture and there is promise of greater development next season.

## OILS AND OIL SEEDS

### *Chaulmoogra Oil*

**British Malaya.**—Mr. B. Bunting, Agriculturist, reports that a block of 20 acres of *Hydnocarpus Wightiana* is now coming into bearing and 150 trees have been placed under observation for recording individual yields. Characteristics of the fruits are also being recorded. It has been observed that the fruits are approximately one year in maturing from the time the flowers are fertilised. Unfortunately a root disease is attacking many of the trees; this is being investigated by the Government Mycologist.

An area of 12 acres of *Hydnocarpus anthelmintica* has recently been planted on undulating land in a laterite loam.

Only *Hydnocarpus anthelmintica* is in bearing at present, the 48 trees in the arboretum having yielded about twice the number of fruits during 1928 that they did during 1927. The average number of seeds per fruit and the average weight of seeds per fruit have also increased.

The young plants of *Hydnocarpus Wightiana* and those of *H. anthelmintica* in the planting-distance experiment are making satisfactory growth.

### Coconuts

**British Malaya.**—Dr. H. W. Jack, Economic Botanist, reports that selection, manurial, cultural and cropping experiments with coconuts were continued during the period July 1 to December 31, 1928. Additional data regarding seasonal variation in oil content of copra from the same palm and variation between different strains have been compiled. This work has entailed estimation of oil content on 188 samples of copra from selected nuts during the period under review.

Mr. C. D. V. Georgi, Acting Agricultural Chemist, reports that, as a result of further experiments, it has been found that the oil content of estate copra, calculated on a moisture-free basis, varies from 64–67 per cent. Further samples of estate copra are being analysed, while samples of both average Ceylon and Malabar copra are being obtained for purposes of comparison.

A series of experiments has been carried out, with the assistance of the Forest Chemist, to determine the quantities of the by-products obtained by the destructive distillation of coconut shells. The results of this investigation have been summarised for publication in the *Malayan Agricultural Journal*.

**Fiji.**—Reference was made in this BULLETIN (1928, 26, 197) to the work being undertaken by H. Maréchal on the improvement of the coconut palm in Fiji. A full account of the work so far carried out, especially in relation to the pollination of the palm, has been published in the *Agricultural Journal, Fiji* (1928, 1, No. 2, p. 16). In an introduction to the article, Dr. J. D. Tothill, Superintendent of Agriculture, points out that the time is not far distant when coconut planters in Fiji will have to consider the question of replanting their estates, and when that time comes it will be desirable to have ready a supply of seed of improved type.

There are individual coconut trees here and there that produce more copra than their neighbours because it is inherent in them to do so. If all the trees in a plantation were of the same stock as the few good ones, the yield of copra would be greater than at present.

It has not been possible anywhere, so far, to collect the good trees into a plantation because the production of nuts in most types of coconuts is dependent on cross pollination. Seed-nuts collected from isolated good trees have consequently produced disappointing trees because they are the result of female flowers on the good trees being crossed with the pollen of the ordinary trees near by.

If some artificial way could be found of carrying pollen from a good tree to the female flower of another good tree, then the resulting nuts would have good parents on both sides and could reasonably be expected to produce trees as good as the parents. As the difficulties did not appear to be insuperable, Mr. Maréchal, who in addition to technical training has had practical experience in plant breeding at the well-known Experimental Station at Buitenzorg, Java, was attached to the Coconut Committee Staff to explore the possibilities.

Mr. Maréchal has been able to keep pollen in an active condition for sixteen days, and as a result of this he has been able to cross selected parent trees successfully. Three small nurseries of what are likely to be commercially pure strains of improved coconuts are now being established, and if the work is pursued diligently there appears to be no reason why a better seed supply cannot be made available to the community. Such seed will not be available for some time, as it takes up to ten years for trees to come into proper bearing. It can probably be made available by the time replanting has to be done on an extensive scale.

In Trinidad, the coconut scale, *Aspidiotus destructor*, is well controlled by coccinellid beetles. Accounts of a successful attempt to introduce the beetles from that island into Fiji are given by T. H. C. Taylor, Assistant Entomologist, in the *Agricultural Journal, Fiji* (1928, 1, No. 1, p. 7, and No. 2, p. 11).

Five different species of coccinellids, which are popularly known as lady-birds, were found to be instrumental in the control of the scale in Trinidad, and it was arranged that large numbers of each species should be shipped for introduction into Fiji. In spite of many difficulties encountered en route, the beetles arrived safely in March 1928, and Levuka was selected as a centre for their distribution. At least one colony has been, or will

be, liberated in each badly-infested scale area throughout Fiji. On islands like Gau and Koro, one batch has been turned out on the west coast and another on the east. The beetles will, it is hoped, distribute themselves from these centres, but when one colony has been liberated in each of the main areas the rate of distribution will be increased artificially by collecting some beetles from the original locality and removing them to other parts of that area by hand.

So far as one can judge at present, the order of importance in Fiji of the five species is as follows :

1. *Cryptognatha nodiceps* Mshl.
2. " Spotted " sp. (unidentified).
3. *Pentilia insidiosa* Mshl.
4. " Small " sp. (unidentified).
5. *Azya trinitatis* Mshl.

*C. nodiceps* is certainly much more efficient as an enemy of the scale than any of the others. It is by far the most prolific, and its life-cycle is the shortest, of them all. Probably *C. nodiceps*, by itself, is capable of doing all that can be done to control the scale by natural means in Fiji, and it is doubtful whether the presence of the others will increase the control materially. The beetles have done very well in the last six months, and it is now certain that this insect will be of great assistance in controlling the scale, which is one of the important coconut pests of the colony.

### *Oil Palm*

**British Malaya.**—Mr. B. Bunting, Agriculturist, reports on the following field experiments with the oil palm in progress at the Government Experimental Plantation, Serdang.

(1) An experiment has been laid down to ascertain the effect of cutting out all female inflorescences on palms up to four years old from the time of planting in the field.

The observations will include :

- (a) Rate of growth.
- (b) Whether the treatment has a stimulating effect by causing the production of an abnormal number of female inflorescences.

It is appreciated that such treatment under estate conditions will have a retarding effect on the multiplication of rats, which become a somewhat serious pest, especially if a good cover crop is established. The amount of fruit produced up to the age of four years does not warrant the expense of harvesting, but it provides sufficient food for large numbers of this pest.

(2) Controlled breeding experiments have been com-

menced on ten high-yielding palms by bagging the female inflorescences whilst they are in the receptive stage and fertilising them with pollen, preserved in desiccators until required, from one or other of the same ten palms. A complete series of crosses, together with self-fertilisation of palms, will produce 100 strains.

(3) The following additional varieties of oil palm have been planted under field conditions for observation of type and also for breeding trials if suitable: Teis B 204, Esok Eyop, Klonde, Ayara Mbana, Henoi Teis 46, Teis 205, Okporoka, Edde.

(4) From the preliminary records of total weight of bunches from the palms during their fourth year in the field it appears that on flat land cover crops have a tendency to retard the production of fruit.

(5) Inter-crops also have a tendency to retard the production of fruit bunches on oil palms growing on flat land.

Experiments 4 and 5 have, however, not been long enough in progress to enable definite conclusions to be formed.

(6) The following further experiments with oil palms have been inaugurated at the Government Experimental Plantation, Serdang:

(a) Ninety-five palms are being kept under close observation and individual yields recorded.

(b) A pollination experiment, of approximately four acres, has been started. One set of sixty-three palms has six female inflorescences per palm artificially pollinated per annum, another set of the same size twelve per palm, a third set has all female inflorescences artificially pollinated, while a fourth set is retained as a control where no artificial pollination is practised.

(c) A preliminary experiment, also about four acres in extent, has been started to compare the effect of "normal" pruning with "minimum" pruning, alternate rows throughout the area receiving one of the methods. "Normal" pruning consists of cutting off all leaves up to but exclusive of those with fruit bunches in their axils, each leaf being cut off at the same time as the bunch in its axil is harvested; this is the usual estate practice in Malaya. "Minimum" pruning consists of removing only such leaves as have turned yellow; this is the method now considered to be more desirable.

(d) One hundred and twenty palms are being kept under close observation, with a view to using them for a manurial experiment.

Mr. C. D. V. Georgi, Acting Agricultural Chemist, reports that the investigation regarding the increase in acidity of palm oil on storage has been continued. The results indicate that with oil of high quality the rate of increase is rather less than 0.1 per cent. per month, the acidity being calculated as palmitic acid.

In view of the probability of shipment of palm oil in tanks in the near future an investigation was carried out regarding the increase in the iron content of the oil when stored in an iron drum. The results of the experiments showed that there was no increase in the iron content after a period of three months.

## FIBRES

### *Cotton*<sup>1</sup>

**British Malaya.**—The Economic Botanist reports that a good crop from selected types of cotton has been harvested and examined as to purity, and the standard has been well maintained. The number of types under experiment has now been reduced to six.

**Fiji.**—Dr. J. D. Tothill, Superintendent of Agriculture, reports that during the half-year ending December 31, 1929, further single-plant selections have been made from a single-seeded type of hardy kidney cotton, obtained originally by Col. Evans from New Guinea (see this BULLETIN, 1928, 26, 205). More than 600 acres of one of the selections have been planted in an isolated district, and the results are being awaited with considerable interest. There is a possibility that this cotton may prove to be of greater value than the Sea Island cotton which has been grown hitherto, but which, at the present prices and with the present weak demand, is unremunerative to most growers.

**Leeward Islands.**—*Montserrat.*—Mr. C. A. Gomez, Curator of the Experiment Station, reports that during the period ending December 1928 the harvesting of the seed-cotton produced from the many cotton experimental plots received the very careful and daily attention of the Station staff. The breeding plots having been increased, harvesting operations proved a much larger undertaking than in previous years. Some 1,500 individual selected trees were under investigation for the various counts, such as loculi value, seed-cotton per boll, lint per boll, bolls per

<sup>1</sup> The volume of Reports received from the Experiment Stations of the Empire Cotton Growing Corporation covering the period 1927-28 has now been published, and is obtainable from the Corporation, price 2s. 6d., post free.

lb. of seed-cotton, lint length, lint index, seed weight, shedding, etc. In order to purify to a very high degree and maintain the uniformity of the Montserrat cotton staple, all flowers appearing in the main breeding plot were self-fertilised. This, although a difficult and expensive task, will supply a better scheme for the most reliable perpetuation of the very desirable characters of the Heaton strains.

Pink bollworm investigation work was continued for the fourth year, and very valuable information is being obtained with the view of securing a second crop of cotton. Further proof was obtained to show that by early planting it is now practical in Montserrat to obtain not only a first crop but some second crop. This early method of planting, however, is not the only means of controlling pink bollworm. Much lies in the proper methods in vogue in cleaning up old cotton fields and the breeding of a type of cotton which is a very early bearer. By these combined factors Montserrat obtained in some places another 20 per cent. second-crop return as well as a full first crop during the year under review. The disastrous storm of September, however, cut off the second-crop prospects prematurely.

**Nigeria.**—Mr. F. D. Golding, Senior Entomologist, reports that surveys of the factors affecting the development of cotton are in progress under his supervision in three localities, viz. Ilorin, Badeggi (Niger Province) and Ibadan. In each locality the local cotton is being tested against improved Ishan strain A. The results up to December 29, 1928, are summarised below.

At *Ilorin* "Ishan A" was tested against "Ilorin," both varieties being inter-cropped with yams. About 47 per cent. of the Ishan flowers have been shed and 27 per cent. of the Ilorin; the corresponding figures at this time last year were 72 per cent. and 41 per cent. Judging from the calculated number of green bolls on the plants, the yields of both varieties will be greater this year than last, and the Ishan yield will approximate more closely to that of Ilorin. Bacterial disease in its various manifestations has been serious this year and is, up to the time of writing, the principal cause of boll-shedding. Cotton stainers have again been scarce and bollworms markedly less numerous than in the 1927-28 season. The virus disease, leaf curl, which was so prevalent last year is almost entirely absent. Jassids were numerous in November, but have not been responsible for much damage.

At *Badeggi* "Ishan A" was tested against "Allen," grown alone. Up to December 15 the Allen cotton had

yielded 229 lb. of seed-cotton per acre, of which about 81 per cent. was clean ; few bolls remained on the plants. The Ishan harvest had only just commenced at that time ; but, as 65 per cent. of the flowers had been shed, it is unlikely that a good yield will be obtained from the first flowering cycle. Jassids and bacterial disease were prevalent on both varieties in November ; stainers have been about eleven times as numerous on Allen as on Ishan.

At *Ibadan* "Ishan A" was tested against "Meko," both being inter-cropped with yams. Up to January 5 both varieties had yielded between 16 and 17 lb. per acre ; 62 per cent. of the Ishan and 39 per cent. of the Meko crop were clean. Bacterial boll-rots and bollworms were responsible for more damage to Meko than to Ishan, but bug damage was greater on the Ishan. Leaf curl is rare this year. Jassids were numerous on Meko earlier in the season, but were rare on Ishan.

The report of Mr. O. B. Lean, Entomologist, for the period ending December 31, 1928, is as follows :

The object of the experiments in progress is to compare the ordinary Munshi cotton with the improved Ishan A cotton from Ibadan. For the usual analytical work there are two  $\frac{1}{16}$  acre plots of each variety selected in a 5-acre block of these two cottons grown through yams. For the stainer gauge the plots are selected in a 5-acre block of cotton grown alone. Unfortunately these latter blocks had to be taken in a block where Ishan, Munshi and Allen cotton was grown, and the stainer gauge has therefore also been taken on the Allen cotton. Flower counts have been taken on the stainer-gauge plots.

The Munshi cotton is normally grown in this locality through yams, though occasionally it is grown alone. It is a cotton very similar to the Ishan and Kabba varieties with a naked seed.

The general growth of the plants was greatly inhibited by the short dry season. Bacterial disease has been common, though never very serious. Leaf curl has been almost absent. Leaf roll was common, and counts showed this to be more common on the Ishan plants than on the Munshi.

Stainers have been almost entirely absent from the cotton grown through yams, though they were common on the cotton grown alone where there was Allen. The cotton through yams has, however, suffered considerably from the attacks of other Rhynchota. On December 1, 5 and 15 106 bugs were collected on bolls for analytical purposes. Of these, only 3 were stainers, whilst 97 were Pentatomidæ

of three "shield" or "stinkbug" types. An epidemic of this type of insect has been reported from the Oturkpo district, and Mr. Lean hopes to visit that area at an early date.

The following are the *stainer-gauge* figures for  $\frac{1}{8}$  acre of each cotton:

Date.					Allen.	Ishan.	Munshi.
Sept.	20	.	.	.	0	0	0
	27	.	.	.	3	1	0
Oct.	4	.	.	.	1	0	10
	11	.	.	.	504	2	39
	18	.	.	.	154	3	4
	25	.	.	.	531	7	81
Nov.	1	.	.	.	272	214	55
	8	.	.	.	170	43	31
	15	.	.	.	66	10	11
	22	.	.	.	160	325	215
	29	.	.	.	468	633	357
Dec.	6	.	.	.	479	924	646
	13	.	.	.	336	928	976
	20	.	.	.	117	312	393
	27	.	.	.	23	101	107
Jan.	3	.	.	.	3	11	10
Total					3,287	3,514	2,935

Only two species of *Dysdercus* were found, viz., *D. supersticiosus* (almost all spotted) and *D. fasciatus*. Most of the latter were taken towards the end of November, and most were found on the Ishan.

The *flower counts* of the cotton grown alone were as follows:

Date. Week ending—					Flowers per week per acre.		
					Allen.	Munshi.	Ishan.
Sept.	22	.	.	.	896	0	0
	29	.	.	.	1,904	224	56
Oct.	6	.	.	.	4,200	336	336
	13	.	.	.	7,728	728	1,512
	20	.	.	.	12,432	1,904	4,536
	27	.	.	.	14,560	3,920	13,272
Nov.	3	.	.	.	21,448	8,680	29,736
	10	.	.	.	20,448	14,560	42,498
	17	.	.	.	15,400	14,336	43,568
	24	.	.	.	8,120	14,840	35,449
Dec.	1	.	.	.	2,856	14,392	17,696
	8	.	.	.	1,736	5,768	3,416
	15	.	.	.	2,296	4,368	2,352
	22	.	.	.	2,800	3,752	1,120
	29	.	.	.	12,152	1,344	2,240
Jan.	5	.	.	.	11,480	5,488	3,864
Total					140,456	94,640	201,651

The *flower counts* for cotton grown through yams are given below :

Date. Week ending—	Flowers per week per acre.	
	Ishan.	Munshi.
Oct. 27 . . . .	10	40
Nov. 3 . . . .	450	70
10 . . . .	1,880	490
17 . . . .	4,980	1,470
24 . . . .	7,480	3,280
Dec. 1 . . . .	5,270	4,000
8 . . . .	3,560	4,060
15 . . . .	1,590	2,500
22 . . . .	610	1,540
29 . . . .	210	920
Jan. 5 . . . .	660	990
Total . . . .	26,700	19,360

The total figures for *bud shedding* up to week ending January 5 (per acre) are as follows :

—	Undamaged.	Buds damaged by			Total.
		Bollworm.	Bacteria.	Doubtful.	
Ishan . . . .	960	150	20	80	1,210
Munshi . . . .	370	70	0	50	490

The corresponding figures for *boll shedding* are :

—	Undamaged.	Bolls damaged by				Total.
		Bollworm.	Bacteria.	Bugs.	Alternaria.	
Ishan . . . .	2,420	320	135	4,225	10	7,630
Munshi . . . .	1,260	180	55	1,305	10	3,100

The percentages of bolls shed undamaged were, Ishan 32, Munshi 41.

The percentages of flowers produced, subsequently shed, were, Ishan 29, Munshi 16.

The totals of *mummied bolls* up to week ending January 5 (per acre) was, Ishan 400, Munshi 120.

The totals of *harvested bolls* up to December 31 were, Ishan 2,670, Munshi 980.

The following is an analysis of damage to locks :

—	Undamaged.	Percentage damaged by			
		Bollworm.	Bacteria.	Bugs.	Anthraxnose.
Ishan . . . . .	48	8	4	36	0
Munshi. . . . .	53	6	11	27	1

In summarising the results, Mr. Lean points out that although no definite conclusions can be made at the present stage of the enquiry, it appears that the Munshi cotton does not produce nearly as many bolls as the Ishan, but that nearly all the pests are less attracted to the Munshi than to the Ishan. The Munshi cotton is about two weeks later than the Ishan.

**Swaziland.**—Mr. R. MacDonald, Cotton Specialist, has furnished the following report on the cotton crop in Swaziland to the end of December 1928.

*Season.*—The season under review has furnished a further example of the difficulties the farmer has to contend with in endeavouring to grow any crop successfully in the territory. The drought of the previous season remained unbroken, with the exception of a small rain in September, until the latter part of November.

From November onwards until the time of writing, the rainfall has been just sufficient for the requirements of the crop, but not enough to establish a reserve of sub-soil moisture to carry on the crop for any length of time, in the event of another drought.

With the exception of part of the low veld, the above statement applies to the whole of the cotton-growing area in Swaziland. The exception referred to is part of the Ingwavuma district, where Cotton Plantations Ltd., the largest producers of cotton in the territory, have their headquarters. In this particular area little effective rain fell between September and the end of December, the result being that the area under cotton has suffered a severe diminution.

*Crop.*—From the above remarks it will be readily understood that little planting could be done until six weeks later than the normal planting period. Small areas were planted in September, following the first rain, but in many cases the ensuing drought necessitated the ploughing out of the greater part of this early planted cotton. Any early planted cotton which was not ploughed under had to have blanks replanted by hand, and, although a full

stand was obtained in this manner, the crop will ripen very unevenly, making picking a tedious and costly process.

The bulk of the cotton crop was planted from November 25 onwards, under conditions favouring good germination, and, with few exceptions, good stands were obtained.

The total area under cotton in Swaziland this season is about 6,000 acres, an appreciable diminution of the area planted last year. The reasons for this diminution are as follows.

Certain soils in the cotton area cannot be ploughed in a dry condition, and as the lack of winter rains prevented any early preparation for the crop, farmers were forced to curtail the acreage they originally intended to put under cotton.

The success of the jassid-resistant strains last season was such that growers decided to plant only jassid-resistant strains. The amount of seed of jassid-resistant strains available was sufficient to fulfil all applications received before the planting season, but there was no further supply to replace the seed lost by drought in the early planted areas.

Despite the smaller area under cotton this year, there are prospects that the actual amount of seed-cotton produced will not fall far short of last season's, provided that the crop receives sufficient rain during the next three months, as freedom from jassid attack will enable the crop to go on producing until a much later date than could be expected in former years.

At the time of writing, the crop, with the exception of the Ingwavuma district mentioned above, is looking well and going ahead rapidly.

*Multiplication of seed of improved varieties.*—In variety tests carried out at the Experiment Stations at Barberton, Magut and Bremersdorp last season a variety named U.4 gave outstanding yields. Seed of this variety was issued to selected growers for multiplication at the beginning of the season. The seed was planted at the rate of 5 to 7 lb. per acre, and in many cases a full stand was obtained. In connection with seed multiplication great credit is due to the farmers and companies who agreed to do this work, for the pains they have taken to ensure successful multiplication of the seed. The total area under this variety of cotton is about 120 acres, and, if the season is favourable, sufficient seed will be available to give every grower a small amount next season.

In addition 200 lb. of the strain named Z. 1-9 was issued for multiplication in a similar manner.

The terms under which the seed was issued for multi-

plication are as follows. The grower was supplied with the seed free and undertook to plant it on land which did not carry a cotton crop the previous season, and to bear all growing and ginning costs of the resultant crop. In return the grower will receive all the lint and 10 per cent. of the seed. The remaining 90 per cent. of the seed will be pooled for distribution throughout Swaziland, and sold at a price fixed by the Empire Cotton Growing Corporation, the money being returned to the growers *pro rata* the amount of seed produced.

*Work at Headquarters.*—With a view to increasing the amount of experimental work carried out at Bremersdorp, a larger area of land was rented from Mr. P. J. Lewis. The block selected extends to 24 acres of level land, and is being laid out with a view to its being used as a permanent Station.

The full programme of cotton experiments planned for the season could not be carried out on account of the late rains. For this reason it was decided to omit time of planting and manuring experiments with the new varieties, and to concentrate on further and more detailed variety tests of the strains which had given the best results during the past year. Spacing experiments for the purpose of comparing three different spacings on two of these varieties have been laid out.

Seed of 120 single-plant selections from the U.4 variety have been planted out for observation and further selection during the present season, in addition to small bulk lots of U.4 and Cambodia strains.

Further trials of rotation crops which may be suited to the territory are being carried on. The crops referred to include ground-nuts, kaffir corns, sunn hemp, sunflowers, and various beans and pulses.

Mr. MacDonald accompanied Mr. Milligan on a tour of the main cotton-growing areas of Swaziland and Portuguese East Africa during December. The question of the general distribution of improved seed was discussed with Mr. Milligan and members of the Bremersdorp Cotton Co-operative Society. It was decided to hand over the distribution to the local branch of the Society, the Corporation reserving the right that their representative should see the allocation list before the actual distribution takes place. The ginning and distribution of improved seed for multiplication purposes will still remain under Mr. MacDonald's supervision.

The supervision of the Sub-station in South Swaziland has been under Mr. Parson, the Corporation's Officer at Magut, during the past year, but, as he goes on leave

shortly, Mr. MacDonald is taking over the work of the Station.

### *Sisal*

**British Malaya.**—The joint investigation of the Agriculturist and Agricultural Chemist on sisal has been continued. The fibre content of the fresh leaves has now increased to more than 5 per cent. The experiments are being continued for a further period of six months.

### RUBBER

#### *Jelutong*

**British Malaya.**—Mr. C. D. V. Georgi, Acting Agricultural Chemist, reports that, as a result of the experiments carried out on the deterioration of jelutong and published in the *Malayan Agricultural Journal* (Vol. XVI, No. 5, May 1928), a further series of the experiments, in which much smaller amounts of iron and copper are added to the latex, have been carried out. The results to date show that a soluble iron salt added to the latex before coagulation in the proportion of 1 part of iron to 20,000 parts of latex will result in the crude coagulum becoming brittle within two months.

The results of the investigation to determine the variations in the moisture contents of separate blocks of jelutong in a consignment have been published in the *Malayan Agricultural Journal* (Vol. XVI, No. 6, June 1928).

Further experiments are in progress regarding the rate of oxidation in air of finely creped jelutong and the variations in the constituents of the latex from different parts of Malaya.

### MISCELLANEOUS PRODUCTS

#### *Tuba Root (Derris spp.)*

**British Malaya.**—Mr. B. Bunting, Agriculturist, states that the results of the experiment to ascertain the optimum age at which to harvest "Tuba Puteh" (*Derris elliptica*) are not yet complete. The dried roots of "Tuba Puteh" obtained from this experiment have been sold locally for export to London.

A similar experiment has been started with "Tuba Merah" (*D. malaccensis*).

Further areas of both *D. elliptica* and *D. malaccensis* have been planted for future observations.

Preliminary experiments with *Derris elliptica* indicate that this variety should be harvested about twenty-three

months after planting, the ether extract of the roots reaching a maximum after this period.

Mr. Bunting points out that in the half-yearly report published in this BULLETIN (1928, 28, 222) the Malay name for *Derris elliptica* should read "Tuba Puteh," and not "Tuba Merah," as printed, whilst that of *D. malaccensis* should be "Tuba Merah," not "Tuba Puteh."

## MINERAL RESOURCES

### BRITISH GUIANA

In connection with a half-yearly statement on the progress of geological survey work in the Colony of British Guiana to the Director of the Imperial Institute, the Commissioner of Lands and Mines has forwarded two reports recently issued by the Legislative Council, the first by Messrs. H. J. C. Conolly, A.R.S.M., B.Sc. (late Government Geologist) and Smith Bracewell, D.I.C., A.R.C.S., B.Sc., Assistant Geologist, 1927-28, "On the Recent Geological Investigations in the Potaro River District," the second that of "the Diamond and Gold Industries Commission."

The geological report deals with the Ewang-Kangaruma diamantiferous district and the Mahdia Konawak gold-bearing district.

The results of the examination of the Ewang-Kangaruma district showed it to consist of surface deposits of laterite, white sand and clay, overlying older Primary rocks. The country examined is almost entirely on the north or left bank side of the Potaro River, next to which is a belt of laterite hills, which rise to 500 ft. above the river. Adjoining the hills almost continuously on the west or Ewang side, on the north and on the east or Kangaruma side are large areas of white sand, some of which is residual and contains angular quartz in places, the rest being alluvial and containing here and there water-worn gravels. These gravels are diamantiferous, and diamonds have been won from almost all the various creeks running through them. Creeks flowing from the laterite, however, contain no diamonds, but some have been worked for gold.

The creek diamonds are derived from the gravel-bearing cappings of some low hills, which were explored by the Survey with the result that their exploitation by large-scale methods did not appear warranted.

The Mahdia Konawak goldfield may be looked upon as a continuation to the east of the area already described.

Similar surface deposits of white sands are present, which contain in places water-worn quartz gravels, clays and laterite—this term being used in a broad sense. All the deposits are either residual or alluvial.

The Eagle Mountain area to the south-east of the district, with its extensive deposits of ferruginous laterite forming cappings to the low hills at the foot of the mountains, has been already described in a report on the Potaro-Ireng district. A few of the cappings had been ground-sluiced for gold, and so it was thought that a detailed examination of them would show whether they could be worked by hydraulicking. Attention was therefore directed to an area of about two square miles between the Crown and Victory hills, as well as, later, to a belt of alluvial ground one mile wide and six miles long on the Potaro road.

In the small area on the hilly ground, detrital laterite forms the solid capping of the flat-topped hills. It is broken up on the sloping ground into boulders and rounded pebbles, and gold-bearing detritus is carried in deep gullies into the alluvial areas and creeks beyond. Examination showed that the hydraulicking of the deposits—the only natural way—was generally precluded on account of shortage of water at high pressure, and the pumping of water was impossible in view of the scarcity of wood fuel.

Apart from the detrital laterite deposits the quartz gravels in the alluvial white sand areas of the district have also been an important source of gold, and of diamonds. The first British Guiana diamond was found in a gold placer deposit.

Altogether in the Potaro district about 500,000 oz. of gold have been already won from surface deposits, the bulk of this from an area of about 14 sq. miles between Eagle Mountain and Mahdia River: this amount of gold is about one-sixth of the Colony's gold production. Almost the whole of the gold won has come from placer deposits and creeks, the latter having been supplied from detrital laterite and from the quartz gravels in the sand belts. At the present time the only gold recovered in the district is from a small dredge which has been in operation since 1914 on the Mahdia River working along  $3\frac{1}{2}$  miles of it and recovering nearly 2,500 oz. per year. It is estimated that for a further  $2\frac{1}{2}$  miles about 20,000 oz. more might be won. Almost all of the remaining creeks have already been worked over.

The Survey estimates, however, that there are still millions of tons of detrital laterite available carrying from 13 to 17 cents in gold per cubic yard.

The report of the Diamond and Gold Industries Commission, which occupies 46 pages, details the work of investigation which was made on the question of the development of the diamond- and gold-mining industries in the Colony.

In the general introduction to the report the diamond and gold industries in the Colony are described with all essential details, including the histories of their development. A further section on these industries describes the methods of production employed, and in it are made suggestions for stimulating these industries.

Further sections deal with (1) the supply of labour, including registered labourers and the tribute system; (2) means of transport, including river transport and postal and telegraph services; (3) general conditions, including police arrangements and medical and sanitary services; (4) revenue; (5) the mining ordinance and regulations. In the last section in which main conclusions are given, the Commission has decided, *inter alia*, that the small operators' activities have built up the diamond industry, and as far as survey work has proceeded there does not seem to be justification for thinking that large-scale operations could be carried on more economically and successfully. On the other hand the future of the gold industry depends on the inauguration of large-scale operations. Among other recommendations are those advising the assistance of *bona fide* prospecting and the modification of the taxation on diamonds.

The report is completed by several appendixes, one being a lengthy memorandum by the Legal Committee of the Imperial Institute, which was written at the request of the Commission, giving suggestions for assisting the development of the gold and diamond industries and also providing a comparative study of British Guiana and other Empire mining laws. The Commission has also sought guidance as to policy to be adopted in dealing with applications for bauxite areas, and the matter will be the subject of a further memorandum from the Legal Committee.

### CYPRUS

The Acting Colonial Secretary for Cyprus has transmitted to the Director of the Imperial Institute the following report by the Inspector of Mines (Mr. H. G. Mountain) concerning mining operations in Cyprus during the six months ended December 31, 1928.

Work has been conducted without interruption at Skouriotissa, and for the six months under review the

production of pyrites shows an increase on tonnage over the corresponding period of 1927.

Progress on development at Mavrovouni has been impeded by the encountering of broken and treacherous ground in the main shaft.

At Amiandos, quarrying was possible up till the middle of November. The fall in the amount of asbestos exported is accounted for by the Company making new shipping arrangements, whereby regular monthly shipments will be made instead of confining export to certain months of the year.

*Pyrites.*—The following statistics relate to the work carried on by the Skouriotissa Mine of the Cyprus Mines Corporation for the second half of 1928 as compared with the corresponding period in 1927 :

	Last 6 months. 1928.	Last 6 months. 1927.
Tonnage mined . . . . .	126,365	113,278
Mining labour (average per day) . . . . .	1,133	1,031
Tonnage exported . . . . .	125,165	91,180
Total surface and underground labour (average per day) . . . . .	1,526	1,425

The following are the statistics for the development of the Mavrovouni Mine of the Cyprus Mines Corporation :

	Last 6 months. 1928.	Last 6 months. 1927.
Shafts, footage sunk . . . . .	562	406
„ labour (average per day) . . . . .	32	16
Boreholes, footage sunk . . . . .	3,234	1,454
„ labour (average per day) . . . . .	27	16
Adits, drifts, stations, footage driven . . . . .	389	218
„ drifts, stations, labour (average per day) . . . . .	72	12

Exploration work has been conducted by the Pyrites Co., Limited, without interruption during the six months under review. Four adits and an incline shaft have been driven with a progress of over 400 ft., and an old Roman shaft cleaned out to a depth of 80 ft. A complete topographical contour survey has been made of the area ; and this is being followed by a geological survey preparatory to a proposed drilling campaign.

Both underground exploratory work and drilling with two machines have been carried out throughout the six months under review by the Anonyme Hellenic Co. at their Mitsero Mines. An additional small body of pyrites has been discovered underground and the drill holes put down have encountered mineralised zones.

*Chrome.*—No export of chrome has been made for the six months. A German company, however, carried out further prospecting work by means of adits on an area

on Troodos, but owing to climatic conditions work was suspended about the middle of November.

*Asbestos.*—The following statistics relate to the work of the Cyprus Asbestos Co., Ltd., during the second six months of 1928, compared with the corresponding period of 1927:

	last 6 months. 1928.	last 6 months. 1927.
Tonnage mined (rock) . . . . .	1,266,203	1,055,090
Tonnage treated . . . . .	285,346	217,843
Tonnage exported (asbestos) . . . . .	7,924	9,274
Average daily labour . . . . .	4,230	3,179

The Company have built an additional primary mill and a further one is in the course of erection.

The yearly output for 1928 reached the figure of 16,287 tons, an increase of over 5,000 tons over 1927.

*Terra Umbra.*—The export of terra umbra for the six months under review was 3,449 tons, compared with 3,319 for the corresponding period of 1927.

*Gypsum.*—During the second six months of the year the export of gypsum stone amounted to 183 tons, and of calcined gypsum to 6,097 tons, as compared with 553 tons and 6,988 tons respectively for the corresponding period of 1927.

In addition to the steady increase in the output from the larger mines, the number of prospecting permits issued is well in advance of those of former years. Towards the end of the year a discovery of a nickel outcrop was reported, but as the place became inaccessible the discovery has neither been investigated nor confirmed.

### FEDERATED MALAY STATES

The Director of the Imperial Institute has received from the Director of the Geological Survey of the Federated Malay States (Mr. J. B. Scrivenor) the following notes on the work of the Survey during the half year ending December 1928.

The geological survey of Johore was completed, and the geological survey of Kelantan was carried as far as considerations of expense and the probable value of results rendered advisable. In the eastern portion of Johore there are possibilities of further developments of tin mining. In Kelantan the prospects of active tin mining are poor, owing partly to the difficulty of access to the known deposits that might repay working. Gold mining in Kelantan is almost extinct, but the ever-increasing efficiency of modern dredges may lead to the Galas River being dredged again.

The geological survey of Trengganu was continued and useful information compiled concerning tin and wolfram deposits. An interesting case of tin ore being derived from hornblende-granite has been reported: a similar case has been reported on Pulau Aur, off the east coast of Johore.

The appointment of a Mining Geologist, attached to the Geological Survey Department, has led to the collection of much useful information from mines that might otherwise have been missed. The Mining Geologist also examined the geological structure of Gunong Bakau, reported on in 1914 by the Director, and confirmed the latter's conclusions as to the mutual relations of the granite, quartz-topaz veins and topaz-aplite.

Torbernite has been found near Gunong Bakau; and a siliceous rock, found at a rubber estate opposite Kuala Plus on the Perak River, may have some economic possibilities.

### GOLD COAST

In a communication to the Director of the Imperial Institute, the Director of the Gold Coast Geological Survey (Sir Albert E. Kitson) sends the following notes on the work of the Geological Survey on raw materials during the half year ending December 31, 1928.

During the major part of the second half of 1928, the staff of the Gold Coast Geological Survey were in England on leave and duty. On their return to the Gold Coast in November and December, they were engaged upon work of a stratigraphical, rather than prospecting, nature.

A few small diamonds have been found and some fair prospects of alluvial gold noted in the course of this work, but nothing of immediate economic importance has been discovered.

A concession has been obtained by a London company over the bauxite deposits in the Yenahin district, west of Kumasi, Ashanti, and it is hoped that in due course these deposits will be developed.

### NYASALAND

The Director of the Imperial Institute has received from the Director of the Geological Survey of Nyasaland (Dr. F. Dixey) a report of the work of the Survey during 1928 and from which the following notes have been compiled.

*Coal.*—During 1928, the Survey ceased drilling operations on the Chiromo coalfield as no reasonable prospect of its economic development seemed likely. Samples from seven coal seams of borehole B.H.3 were forwarded

to the Imperial Institute for examination, the two most satisfactory seams, namely those at depths of 682 ft. and 780 ft., yielding the following analyses :

	Analyses of Chiromo Coals.	
	682 ft. (7 ft. thick). Per cent.	780 ft. (8 ft. thick). Per cent.
Fixed carbon . . . . .	70·74	70·28
Volatile matter . . . . .	9·97	5·41
Ash . . . . .	17·10	21·02
Moisture . . . . .	2·19	3·29
Sulphur . . . . .	0·64	0·62
Calorific value (calories) . . . . .	6,606	6,040

These coals are of non-coking type and semi-anthracitic in character.

*Asbestos*.—The rocks of the southern part of Ncheu District comprise principally a series of gneisses invaded by small lenticular masses of serpentine which has been in part replaced by asbestos, talc, kyanite and hornblende.

Two types of asbestos have been recognised, viz. amphibole and chrysotile, the unweathered portions being white to pale green in colour. The principal exposures lie along the slopes of the northern side of the Mwendangombe Valley, the upper Ngurudzi, and the upper Nyanga. At least thirty outcrops have so far been recorded, but the rocks are almost completely covered with grass, scrub and bush. Numerous excavations ranging down to 20 ft. have been made in the deposits, but in all cases these excavations lie only within the zone of weathering, and until this is penetrated and fresh samples recovered it is impossible to express a definite opinion as to the quality and maximum market value of the asbestos. Samples so far submitted for examination, however, appear to represent a marketable product, and the quality of the mineral may be expected to improve with depth.

The most promising deposit observed is situated near the eastern foot of Choma Hill. The outcrop is at least 250 yards in length and 50 yards in width, and a cutting 16 ft. deep into the unweathered mineral shows parallel vertical veins traversing felted asbestos. The veins, which are well exposed on a face 10 ft. wide that cuts across the strike, are numerous and almost in contact over much of the face, and clearly make up a large proportion of the exposed part of the deposit. Whether or not these conditions persist throughout can only be determined by further excavations ; but the deposit has the appearance of being extensive enough for commercial development, and would appear to deserve examination over a greater area and to a greater depth than has so far been attempted.

*Graphite.*—Several new occurrences of graphite in the Port Herald Hills have been noted during the year, and representative specimens have been forwarded to the Imperial Institute for examination. On the Nachipere River, at the crossing of the path from Ngulumba village to the old Government Farm, there is a band of graphite-schist three yards in width striking north-east and south-west. Graphite-gneisses are exposed near Tangadzi Stream, a left-bank tributary of the Nachipere; the graphite often occurs only as isolated flakes, but locally it is present in considerable quantity. Graphitic biotite-garnet-gneiss occurs also near the headwaters of Ngoma Stream about three miles south of Chididi on the path to Chingoma.

The carbonaceous sandy shales and sandstones of the Nachipere Series become graphitic with increasing metamorphism, and in Nachipere Stream there are several lenticles of graphite-schist up to two feet in thickness that appear to have originated in this way. Graphitic gneisses are exposed also in the Likangala River near the Police Camp at Zomba.

*Iron Ore.*—Iron ores associated with white quartzite occur on the low ridge three to four miles south of Namalambo Hill, at the northern end of the Port Herald Hills. One sample on analysis gave 96.42 per cent. of iron oxides, equivalent to 69.77 per cent. of metallic iron.

The white medium-grained feldspathic quartzite carrying the ore extends in a north-easterly direction from the Namalambo-Mlaka fault towards the Shire alluvium; the outcrop is about three miles in length and half a mile in breadth. On the north-westerly side of the outcrop the ore is ilmenite, and it occurs in narrow bands and lenticles, alternating with the quartzite, up to 10 ft. in length; where best developed the ore does not make up more than about 3 per cent. of the rock. On the south-eastern side of the outcrop the ore is magnetite; the larger lenticles range up to 10 ft. in length and 2 ft. in thickness. Large concentrations of magnetite rubble have accumulated locally on the surface of the quartzite. Similar deposits of iron ore were seen about three miles north of Mlaka Hill, and near the head of Limbaufe Stream the ore appeared as thin lenticular bands in quartz-schist.

The ilmenite of the Nankande and Panga streams (see *Mineral Survey Report*, 1906-9) is essentially similar in mode of occurrence to the magnetite of the Namalambo area, but contains more ferro-magnesian and titaniferous minerals.

*Economic Survey of the Proposed Railway Extension*

*from Blantyre to Lake Nyasa.*—Ample supplies of brick-making clays, building-stones, limestones, and cement materials occur in the region traversed by the proposed railway extension, ten samples of limestone, lime and clay having been forwarded to the Imperial Institute for examination.

The limestone occurs principally between Blantyre and Matope, at Chenkumbi Hill, and in the hilly country thirty miles south of Kasanga, the latter deposit hitherto being unrecorded.

The problem of providing adequate water supplies for the use of the railway is likely to present considerable difficulty, but there is reason to believe that satisfactory supplies could be secured by boring.

### SOUTHERN RHODESIA

The Director of the Imperial Institute has received from the Director of the Geological Survey of Southern Rhodesia (Mr. H. B. Maufe) the following notes on the work carried out by the Survey during 1928.

*Gold.*—During 1928 the Geological Survey of Southern Rhodesia made an intensive study of some of the gold-mines. The Gaika Mine, Que Que, was examined by Mr. Morgan, whose report is being followed up by a scheme of development. The mine is situated within the eastern margin of a body of the Basement Schist formation in contact with which is the western edge of an extensive granite batholith. The Basement Schist formation in the vicinity of the mine is represented by a belt, up to half a mile in width, of talc-carbonate-schist nearly separated from the main Basement Schist body by a narrow tongue of granite. Lens-like bodies of serpentine and "dolomite" (the local name for a carbonate-rock composed largely of magnesite) and irregular bodies of greenstone are associated with the talc-carbonate-schist. Intrusive into the schist are epidiorite, porphyrite, aplite and dolerite. The ore bodies occur in the schist belt. They strike in a roughly north-west to south-east direction and dip to the north-east at an average angle of about 68 degrees. The Shamva Mine was examined by Mr. Tyndale-Biscoe with the object of elucidating the structure of the country-rock and the relations of the ore bodies thereto. The homogeneity of the quartzite, of which Shamva hill is mainly composed, rendered this a difficult matter, particularly in the main ore channel, while the evidence provided by the bands of schist, which occur mainly in the South Parallel ore channel, is only of a negative character, since they show the absence except at one locality of any extensive cross-

faulting which could shift the ore bodies. It is therefore concluded that faulting has not been a major factor in the production of the present forms of the ore bodies.

In general the ore bodies appear to be of a lenticular shape, and the axes of the lenses are inclined towards the north-east at high angles. They probably represent successive depositions of gold from solutions which rose along definite ore channels. Certain recommendations have been made for future development, based on the results obtained.

Mr. Macgregor began an examination of the Globe and Phoenix Mine at Que Que. The importance of the geological structure is recognised on the mine, and the geology is being studied by the Manager Mr. C. S. Rix and his colleagues as time permits among their other duties. The complicated vein system of the mine traverses the marginal portion of the granite and the older schists, principally magnesite-rocks, which dip beneath it. The vein-system seems to have been formed by subsidence due either to earth movement or to contraction during the formation of the magnesite rock. The change which these rocks have undergone is therefore one of considerable economic importance. The order of mineral precipitation in the mine is (1) carbonate veins, (2) porphyrite dykes, (3) gold-stibnite-quartz and (4) stibnite.

Mr. Lightfoot paid a short visit to the Rezende Mine, Penhalonga, to examine the latest developments on the 13th, 15th and 17th levels. He was allowed access to all plans and previous reports, and certain recommendations were made as to development.

In addition to the above over fifty smaller mines and developing claims were visited by members of the Geological Survey staff. Many of these are of interest.

The Kanyemba Mine, Umsweswe, was examined by Mr. Keep. The reef is a gold-quartz vein interbedded in sedimentary schist forming a pitching anticline the axis of which dips to the south-west at about 30 degrees. The values occur in a shoot pitching at an angle to the axis of the anticline, the shoot and the axis coinciding in the upper level but gradually diverging at depth. The shoot, which has an average width of 250 ft., extends for a distance of 1,500 ft. incline depth, the gold being found in association with quartz stringers intruded into a fractured older quartz reef which itself, in the absence of the younger quartz, is barren of gold. A belt of badly sheared rock of similar composition to the country-rock of the reef and striking from north-east to south-west is first encountered in the northern side of the stope on No. 8 level. This belt

is transgressive across the ore shoot, completely cutting off the values at the thirteenth level, the barren, earlier quartz alone being present on its northern side. In these circumstances and particularly in view of the fact that a large amount of prospecting work had been done at depth with negative results, it was not considered advisable to make any recommendations for further work.

Mr. Lightfoot accompanied the Government Mining Engineer to lay out a borehole to test the Seigneury Mine situated in the Hartley District. The reef in this mine was cut out by a "dyke." Examination showed that this was more probably an inclined sill of dolerite. A hole was drilled 500 ft. south of the main incline shaft. This was the first hole drilled by the government mining drill and was completely successful. The dolerite dyke was cut at the depth expected, was proved to be 50 ft. thick, and the reef was later intersected carrying payable values. The owner has now decided to proceed with the re-development of the mine.

Mr. Lightfoot spent three weeks at the Giant Mine, Gadzema, making a geological map of all surface exposures within a radius of  $1\frac{1}{2}$  miles of the mine. The Giant lode, one of the richest concentrations of gold in Southern Rhodesia, was cut off by faults at a depth of 800 ft. from the surface and was never found again. During the life of the mine it was thought that the faulting would cause a large lateral shift on account of the intense smashing observed below the reef.

After a careful examination of the records in the possession of the Geological Survey it became obvious that there is a large sector underlying the lode, which has never been explored. A series of cross-sections were drawn and a model constructed both of which showed up this unexplored zone very clearly. The probable effects of the complex faulting was worked out graphically, and it can be shown that a very likely position for the lost reef would be in the unexplored sector. The exploration of this unproved zone is considered to be a legitimate mining speculation. A summary of the evidence as to how this conclusion was arrived at was drawn up, and handed to a syndicate interested in the reopening of the mine.

The Mayfair Mine situated in the Insiza District was visited by Mr. Lightfoot. The main mass of rock surrounding the mine is composed of greenstone-schists, an ancient volcanic series composed of lava flows intruded by dykes. Associated with this volcanic series is a narrow strip of banded ironstone, grit and limestone. The gold

is confined to this sedimentary group. The outcrop of the banded ironstone was followed for a considerable distance at the surface, and was found to be folded in a peculiar manner. Gold has been found along this outcrop. Suggestions were made for further development work to be carried out along this zone. Examination of the minor faulting within the mine enabled development work to be suggested which led to the opening up of the ore body on the second level. The ore body seems to have been formed from a band of impure limestone which has been heavily mineralised with pyrite, pyrrhotine and mispickel. It also contains free gold which can usually be seen in polished sections of ore even from the lower levels.

The Lovell gold claims, situated six miles south-south-west of the Golden Kopje Mine, Lomagundi district, were visited by the Director. A quantity of white quartz rubble, which had obviously been turned over by the ancients, is spread around and in part occupies the floor of a broad trench-like hollow which looks like an ancient working excavated in the slates and quartzites of the Lomagundi system. Four shafts were sunk in the floor of the hollow through a thick deposit of shattered and distributed slate, partly fresh but mostly much decomposed. In this were blocks of quartz, of dolomite and of metasomatic quartzite. It became obvious that the hollow was partly, if not wholly, a "swallow-hole" due to solution of dolomite. Coarse gold may be panned from many parts of this filling. It seemed to be associated with the blocks of a grey quartz differing from that of the surface rubble. The grey quartz has probably been shed from a reef in the slates on the hanging wall side of the hollow, but its location is not very easy.

Mr. Keep visited the Camperdown Mine, Selukwe, at the request of the option-holders. A week was spent studying the geology of the deposit, and the lines upon which further work should be laid out were indicated. A large amount of oxidised ore owing its economic value to secondary enrichment is developed, the ore body being a replacement deposit in a shear zone in banded jaspilite.

*Chromite.*—An intensive study of some forty square miles of chromite-bearing rock in the Umvukwe Mountains, Lomagundi and Mazoe districts, was made by Mr. Keep.

The chromite deposits occur in the Great Dyke of Southern Rhodesia, a geological feature extending in a north-north-east to south-south-west direction for about 330 miles through the country, with an average width of about four miles. The exact mode of origin of the Great Dyke is not known, although it is almost certainly not a

dyke in the true sense of the word. It consists almost entirely of basic and ultra-basic igneous rocks which contain in different parts chromite seams, platinum ore and asbestos.

The chromite ore, containing from 49 to 56 per cent. chromic oxide, occurs in the form of narrow seams in serpentine and to a minor extent in enstatite-rock and websterite. The serpentine is an altered enstatite-rock which may have contained a little olivine in places. No certainty as to the original source of the serpentinising waters can be expressed although paulo-post metamorphism of the original ultra-basic rock, with the formation of serpentine-rock, appears to be the most probable cause of the serpentinisation. That magmatic waters and fugitive elements were active during the final stages of the intrusion of the Great Dyke is proved by the presence of small siliceous and pegmatitic intrusions in the Great Dyke in other areas.

Dolerite dykes are intrusive into the Great Dyke and cut the chromite seams. They vary from 1 in. to 150 ft. in thickness and invariably possess fine-grained edges.

There appears to be a maximum of seven seams of chromite ore varying in thickness up to 30 in., with an average of about 7 in. The seams dip towards the middle line of the Great Dyke at angles of about 30 degrees, the uppermost, or most central, seams commonly having the lowest angle of dip.

The foot and hanging walls of the seams usually consist of chromite-rich or chromite-poor serpentine-rock, except in those cases in which the wall of a particular seam is the plane of a fault. In this case a band of magnesite and opaline silica varying up to 6 in. in thickness is found on that wall. In places, but rarely, the chromite seams occur between walls of unserpentinised rock, as has been stated.

It has been noted, during the examination of over a hundred exposures of chromite, that no rule can be given as to the occurrence of a chromite-rich casing on the foot or hanging walls of any seam. In some cases from two to four inches of serpentine-rock plentifully besprinkled with chromite crystals occurs on both walls of a seam, this type of rock passing imperceptibly into serpentine-rock showing no exceptional quantity of such crystals. Occasionally the chromite-rich serpentine rock is only seen on one wall, either foot or hanging, and in other cases it is entirely absent.

The importance of the above observations lies in the light they shed on the mode of origin of the chromite

seams. It is obvious that the seams are not replacement deposits. It has been concluded that they were originally formed by a process of magmatic segregation, and that formerly they occurred in horizontal beds, the synclinal pseudo-stratification which is now visible having been caused by earth movement after the solidification of the chromite. It appears probable that the contraction of the rocks following upon cooling, after intrusion and serpentinisation, may have been the cause of the sinking of the central portion of the Great Dyke relative to its edges.

Faults transverse to the Great Dyke are common, many being filled by magnesite-opal veins, suggesting that they were formed before the rock had finally cooled after serpentinisation. In all cases the chromite seams have themselves been faulted, though usually but slightly, by the transverse faults.

From the evidence afforded by outcrop workings, and from field exposures where chromite seams extend at least 1,000 ft. down the dip from the highest point on their outcrop, it has been estimated that the forty square miles of the Great Dyke mapped contain between two and two and a half million long tons of chromite ore to 100 ft. of incline depth. In places, it is almost needless to remark, mining costs would be prohibitive for even so shallow a depth, whereas in other places mining to depths below the outcrop of a particular seam of over 1,000 ft. will be an economic proposition. At the present time transport costs to the nearest point on the railway render chromite mining in this area almost an impossibility. It is, however, expected that this position will shortly be improved by the construction of a railway.

*Asbestos.*—Mr. Keep examined the Ethel Mine, Lomagundi District, the only producer of chrysotile asbestos from the Great Dyke of Southern Rhodesia. The mine is situated on the western flank of the Umvukwe Range, at a point where the Dyke is offset to the east for a distance of approximately three-quarters of a mile on the northern side of an east and west line of fracture. That this is an important zone of structural weakness is shown by the occurrence in it of a quartz reef intersected by and therefore older than the Great Dyke and of a dolerite dyke intersecting and therefore younger than the Dyke.

The situation of the asbestos deposits on this east to west line of fracture cannot be regarded as accidental, the direction of strike of all the major seams of fibre being also from east to west with vertical dips. Mr. Keep considers it probable that the asbestos was formed during the cooling

of the serpentinised enstatite-rock in which it is found. Immediately subsequently to the completion of serpentinisation, excess of siliceous waters saturated with serpentine would deposit its load in the shrinkage cracks of the serpentine-rock as cooling progressed, thus forming the chrysotile asbestos. The shrinkage cracks would naturally tend to form along the pre-existing lines of weakness already described.

That the formation of the asbestos is not due to surface waters is well shown by the fact that the fibre is found over 100 ft. below water level, and that it must have been formed at a period when the land surface had not been eroded to its present level. The great age of the asbestos is proved by the fact that a 1-in. dolerite dyke, an offshoot from the main dolerite dyke, is found intruded into a seam of fibre, which is completely altered to a complex mixture of magnesium salts of no economic value.

To explain the origin of the siliceous waters to which the serpentinisation of the enstatite-rock in the area is due is a very difficult matter. It is possible that they themselves accompanied the intrusion in its final stages, acid dykes of a pegmatitic or aplitic nature being common in some portions of the Great Dyke.

The chrysotile asbestos produced by the Ethel Mine is of very fine quality, the colour, flexibility and tensile strength being as good as, or better than, that of any other chrysotile fibre yet examined by Mr. Keep. When the analyses of the commercial fibres from the Ethel Mine, from Shabani and from Canada are compared, one is immediately struck by the large percentage of theoretical (that is, pure) serpentine in the mineral composition of the Ethel Mine fibre, this being greater than that in any other asbestos yet examined by the Survey.

*Coal.*—A re-examination of the portion of the Wankie coalfield adjoining the railway line was made by Mr. Lightfoot. Since the first mapping of the field in 1913 a number of bores have been put down which throw a good deal of light on the stratigraphy of the Karroo beds, and have proved the existence over a considerable area of a 30-ft. seam of steam coal, all of which is of workable quality. The seam as worked in the present colliery is not over 12 ft. in thickness. A large collection of glossopterids and other fossil plants was made from a newly discovered locality, and has been submitted to Mr. John Walton of Birmingham University for determination.

*Corundum.*—A new discovery of corundum on the borders of the Wenimbi Estate and the Soshwe Native Reserve in the Marandellas District was visited by the

Director. A bed of surface rubble a foot to 18 in. thick shows clean crystals of grey corundum which are abundant in patches. Below the gravel is in places a mottled earth containing corundum crystals, and doubtless representing a much decomposed aluminous schist. Traces of banded ironstone, quartzite, amphibolite and pegmatite in the pits and trenches indicate that the corundum was developed by the metamorphism of the surrounding granite and its pegmatite dykes in a band of aluminous schists belonging to the Banded Ironstone group. The occurrence is thus similar to that at Rusapi. The possibilities of marketing this corundum have been investigated by the Imperial Institute.

*Mica.*—A new field of mica in the Darwin district is now producing good quality ruby mica at the Idol Mine. The occurrence is similar to that in the Miami field situated 150 miles to the east, that is to say, the mica books occur in pegmatite dykes intrusive into coarse crystalline micaceous schists.

*Soils.*—The comparative study of a red clay and of a black *vlei* soil both derived by decomposition from the same dolerite sill under different topographic conditions was made by the Director. Suites of analyses of the fresh rock, decomposed rock, sub-soil and soil were made by Mr. E. Golding, Chemist to the Geological Survey.

In the case of the red soil almost complete leaching of the alkaline earths and of the soda with very heavy losses of potash and of phosphate, a heavy loss of silica and lesser losses of alumina, iron and manganese were found to have taken place, assuming that the titania remains constant. Comparison with similar soils in the Transvaal 8 degrees farther south suggests a nearer approximation to lateritic conditions in Rhodesia (greater loss of silica, less loss or apparent concentration of iron and manganese as compared with alumina).

The black *vlei* soil occurs on ground which is water-logged during the rains, remains wet after the red soil has dried out, but ultimately itself dries up. It is similar to the "black turf" soil of the Union of South Africa, and to the black cotton soil, or *regur*, of Kenya and peninsular India. A similar suite of analyses shows the same considerable leaching of the alkalies, alkaline earths and phosphate, and less effective leaching of the silica, alumina, iron and manganese. Potash shows less loss in the black *vlei* soil. The black *vlei* soil profile shows a greater relative abundance of the more soluble alkalies, alkaline earths and phosphate in the soil and sub-soil. This is attributed to the evaporation of the abundant

soil water during the dry season. The difference in colour between the red and black soils is attributed to the state of combination of the iron. Comparison is made with Marchand's conclusions regarding similar black soils in the Transvaal in a paper published in vol. xxv. of the *South African Journal of Science*.

### SIERRA LEONE

The Director of the Imperial Institute has received from the Director of the Geological Survey of Sierra Leone (Major N. R. Junner) the following notes on certain mineral occurrences in the Colony.

*Marampa Haematite Deposits.*—A considerable amount of development work was carried out during 1928 on the Concession granted to the African and Eastern Trade Corporation over the hæmatite deposits in the Marampa Hills, Port Lokko District. It is understood that this work has already proved the existence of between 10 and 15 million tons of high-grade ore and it is anticipated that this quantity will be increased when the development work now in progress is completed. A survey party is at present engaged in reporting on a route for a proposed railway line from the deposits to a proposed deep-water port on the Sierra Leone River. The falls and rapids on the Rokell River within eight miles of the hæmatite deposits are capable of supplying large quantities of water-power.

*Gold and Platinum.*—Applications have been received for Exclusive Prospecting Licences covering an area of more than 40 square miles in the gold-bearing belt in the Koinadugu District of the Northern Province and tenders have been accepted by the Government for Exclusive Prospecting Licences over an area of about 20 square miles in the platinum-bearing district in the Colony.

*Other Minerals.*—Deposits of low-grade manganese ore and graphite have been found in several places in the Sembehun District of the Southern Province, and small deposits of better quality graphite have been located in the same district and in Koya Chiefdom of the Port Lokko District. An average sample showed on analysis 16.7 per cent. of manganese, 5.6 per cent. graphite and 0.5 per cent. vanadium pentoxide.

### UGANDA

In a communication to the Director of the Imperial Institute the Acting Director of the Geological Survey

of Uganda (Mr. W. C. Simmons) gives an account of the work carried out by the officers of that Department during the latter half of 1928.

In the Western Province, the Director (Mr. E. J. Wayland) visited the western slopes of Ruwenzori and the copper deposits at Kilembi, and also accompanied the Anglo-Persian Oil Co.'s geologist on a tour of inspection, in the interests of the D'Arcy Exploration Co.

He also paid several visits to Jinga in the Eastern Province to examine the high-level gravels, and similar deposits in the Sango Bay area were also inspected, the latter work being in connection with lost tin leads. Similar work was also carried out at Katera, S. Koki.

The occurrence of the new bismuth mineral at Mile 30 on the Kampala-Mubendu road was visited by Mr. W. C. Simmons, who later visited the Sukulu Hills in the Eastern Province in order to explore for minerals the large crystalline limestone mass of the Sukulu Hills and Tororo Hill and to determine their age and mode of occurrence. Much magnetite, biotite, mica and apatite were observed in the crystalline limestone. No other economic minerals were noted and no outcrops of junctions with other rocks were observed.

The Bufumbira and Ankole tin areas were systematically examined by Mr. A. D. Combe, who is preparing a report on the tinstone occurrences, which appear to be peculiar. The volcanic rocks of Bufumbira are important petrologically and also interesting. Mr. Combe has mapped all of the separate flows of the three big volcanoes and also numerous smaller ones.

Boring for water supplies in the N.E. Soroti District was continued by Mr. S. Gill. Water supplies in this district and also in Karamoja are precarious in the dry season. The supply at the cotton experimental farm at Serere is being investigated.

In his report on the Survey laboratory work, Mr. Simmons states that during the six months 158 samples sent in by prospectors were examined, in addition to those sent in by the Officers of the Survey. Several prospectors sent in samples of the new bismuth-tantalate mineral which has been analysed at the Imperial Institute. Further specimens of Kilembe copper ores were received. These now include malachite, azurite, cuprite, tenorite, chrysocolla and copper pyrites. Mr. Wayland also brought in from his tour a good series of specimens of the ores and country rocks.

Public prospecting is going on keenly in many parts of the Protectorate, including Karamoja and the north-

east, Ankole and Kigezi, Toro, parts of Buganda and in the Eastern Province round Tororo. As a result of this work many samples are sent in, as well as numerous requests for geological and mineral information concerning these areas.

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### Gums and Resins

Onderzoek van Gom van *Acacia decurrens* uit Nederlandsch-Indië. By M. J. van Royen. *Berichten No. 40, van de Afdel. Handelsmuseum van de Kon. Vereen. Kol. Instituut*. Pp. 12,  $8\frac{1}{2} \times 5\frac{1}{2}$ . (Amsterdam: Koloniaal Instituut, 1928.) Reprinted from *De Indische Mercuur*, December 5, 1928.

A Contribution to the Life History of the Lac Insect, *Laccifer (Tachardia) lacca* (Coccidae). By Pratap Singh Negi. *Bull. Entom. Res.* (1929, **19**, 327-341).

Contribución al Conocimiento y Mejoras del Aguarrás Español. By M. Tomeo. *Servicio Forestal de Investigaciones y Experiencias, Inst. Nac. Invest. Exper., Agron. y Forest., Madrid* (1928, **1**, No. 1, Sección de Resinas, 12-22).

El Pino y Sus Derivados. By M. Tomeo. *Servicio Forestal de Investigaciones y Experiencias, Inst. Nac. Invest. Exper. Agron. y Forest., Madrid* (1928, **1**, No. 1, Sección de Resinas, 23-27).

El Aguarrás Español de Pino de Alepo. By M. Tomeo Lacrué. *Servicio Forestal de Investigaciones y Experiencias, Inst. Nac. Invest. Exper. Agron. y Forest., Madrid* (1928, 1, No. 2, 116-119).

El Aguarrás Español de Pino Piñonero. By M. Tomeo Lacrué. *Servicio Forestal de Investigaciones y Experiencias, Inst. Nac. Invest. Exper. Agron. y Forest., Madrid* (1928, 1, No. 2, 120-125).

La Industria Resinera y Su Técnica. By M. Sevilla Peñalva. *Servicio Forestal de Investigaciones y Experiencias, Inst. Nac. Invest. Exper. Agron. y Forest., Madrid* (1929, 2, No. 3, 112-121).

### *Tanning Materials*

Fertilizer Trials with Wattles. By J. B. Osborn. *Farming in South Africa* (1929, 3, 1227-1229).

I. Manuring of Wattles. By C. O. Williams. II. Fertilizer Trials with Wattles. By J. B. Osborn. *Div. of Chem. Series No. 92, Dept. Agric., Un. S. Afr.* Pp. 10,  $9\frac{1}{2} \times 7\frac{1}{4}$ . (Pretoria: Government Printer, 1929.) Reprinted from *Farming in S. Africa*, October 1928, and January 1929.

Tizrahholz und Tizrahextrakt. By W. Vogel. *Collegium* (1929, No. 706, 68-74).

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## NOTICES OF RECENT LITERATURE

*Books for review should be addressed to "The Editor, Bulletin of the Imperial Institute, South Kensington, London, S.W.7."*

THE OUTWARD BOUND LIBRARY. (1) THE AUSTRALIAN BUSH. By Mary E. Fullerton. Pp. xvi + 242. (2) THE CITIES OF AUSTRALIA. By Kathleen Ussher. Pp. xviii + 204. (3) THE MALAY PENINSULA AND ARCHIPELAGO. By Ashley Gibson. Pp. xi + 236. (4) THE NEW ZEALANDERS. By Hector Bolitho. Pp. xvi + 176. (5) THE EGYPT OF THE SOJOURNER. By Gladys Peto. Pp. xiii + 238. (6) MALTA AND CYPRUS. By Gladys Peto. Pp. xiii + 256. Each  $6\frac{3}{4} \times 4\frac{1}{2}$ . (London and Toronto: J. M. Dent & Sons, Ltd., 1928-9.) Price 5s. each.

These handy volumes are the first six of an excellently produced series intended "for the information and entertainment of travellers and emigrants and their friends at home." The books are very attractive, and, though varying in style and arrangement according to the particular author, are on a high level throughout, and furnish a great deal of interesting and useful information on the natural and economic features of the countries concerned and the life and characteristics of their inhabitants. The illustrations, which are good, are mostly in the form of sketches. The volumes should find a wide circle of appreciative readers.

BRITISH COLONIAL POLICY AND THE SOUTH AFRICAN REPUBLICS, 1848-1872. By C. W. de Kiewiet, M.A., Ph.D. Pp. xiii + 317,  $8\frac{3}{4} \times 5\frac{1}{2}$ . (London: Longmans, Green & Co., Ltd., 1929.) Price 12s. 6d.

This work is one of a series of "Imperial Studies," issued under the general editorship of Professor A. P. Newton, Rhodes Professor of Imperial History in the University of London. As the title indicates, it is of a rather academic character, but it is a readable book which should prove of considerable value to students of South African history. The author, who describes his treatise as "An analysis of the relationship between Great Britain and the Republics," has made use of a large mass of manuscripts as well as published material, a bibliography of which forms a useful appendix to the volume.

THE EVOLUTION AND CLASSIFICATION OF SOILS. By Dr. E. Ramann, translated by C. L. Whittles, M.A., Ph.D. Pp. xii + 127,  $8\frac{1}{2} \times 5\frac{1}{4}$ . (Cambridge: W. Heffer & Sons, Ltd., 1928.) Price 7s. 6d.

The conception of the soil as a subject for purely scientific research and not solely as an adjunct to practical agriculture is of comparatively recent growth, and the author of this book was one of the pioneers in this branch of study.

The earlier part of the book gives a good account of the different agencies (weathering, action of circulating water, action of organisms, including micro-organisms as well as higher plants and animals and man) responsible for the formation of soil from the parent rock, and shows how these agencies, together with the climatic factors such as temperature, precipitation and evaporation, may develop different types of soil either from the same or from different kinds of rock.

The author then discusses various classifications, particularly Russian, but does not altogether follow the modern Russian systems, which are not applicable to all types of soil. That adopted by the author is on a very broad basis, almost too broad for general use, but it is free from some of the disadvantages of other systems.

The author's classification recognises four geographical zones, namely, the Cold, Cool-Temperate, Sub-Tropical and Tropical. These are subdivided into "regions," according to the climate, which is classified as humid (uniformly moist), semi-humid (or periodic in which the humid character is predominant), semi-arid (or periodic in which the arid character predominates) and arid (uniformly dry). The consideration of various local factors

leads to further subdivision and renders possible the classification of local types of soil within the broad limits of the climatic zones. This method allows for proper consideration of the great variations found in soil and gives scope for extension as detailed knowledge of soil types increases.

The book includes a useful list of references to literature, and is very readable.

**FERTILISERS AND MANURES.** By Sir A. Daniel Hall, M.A., Sc.D., LL.D., F.R.S., K.C.B. Pp. xxiii + 414, 8 $\frac{3}{4}$  × 5. Third edition, revised and enlarged. (London: John Murray, 1929.) Price 8s.

The new edition of this standard work has been rendered necessary by the great advances which have recently been made in the processes employed for the manufacture of artificial manures and by the change in the economic position of fertilisers, a change which has been so considerable as to lead to new developments in farming. Revision was also needed in view of the new additions to our knowledge of the soil and the action of fertilisers on it.

The work has been thoroughly revised and enlarged, and will continue to be indispensable as an up-to-date textbook for farmers and students of agriculture.

**SUCCESS ON IRRIGATION PROJECTS.** By John A. Widtsoe, Ph.D., LL.D. Pp. v + 153, 8 × 5 $\frac{1}{4}$ . (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1928.) Price 8s. 6d.

This work, which is based on a series of lectures given by the author at the Utah Agricultural College, is intended to impart to non-technical readers the main principles underlying the practice of irrigation. After a brief review of the history of irrigation enterprise in the United States, the factors involved in successful reclamation by irrigation are discussed, and reference is made to the wise and proper use of irrigation water, the advantages and disadvantages of irrigation, the cost per acre of the various United States Federal irrigation projects, and the principal economic factors involved in farming on irrigated land.

**CO-OPERATION IN AGRICULTURE.** By H. Clyde Filley, A.M., Professor of Rural Economics, University of Nebraska. Pp. xix + 468, 9 × 5 $\frac{3}{4}$ . (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1929.) Price 20s.

The author of this work states in his preface that it is "the development of a set of lessons which were prepared

for student use at the University of Nebraska," and that it is not an encyclopædia of co-operation but merely attempts to present the facts which Professor Filley believes to be of the most vital interest to Americans. It is, however, a well-arranged and very instructive work, which should be useful to those interested in co-operative movements from either the historic or practical standpoint. The main subject dealt with is agricultural co-operation in America, including methods of marketing and finance. Many statistical tables and diagrams are supplied, and each chapter is followed by a short list of publications suggested for further study.

PRACTICAL CO-OPERATIVE MARKETING. By A. W. McKay, B.S., and C. H. Lane, M.A., Ph.D. Pp. xvii + 512, 8 × 5½. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1928.) Price 15s.

This book gives an account of the progress that has been made, particularly since 1915, in the formation of marketing and purchasing associations in the United States. The various questions relating to co-operation in the distribution of dairy produce, poultry, potatoes, fruit, livestock, cotton, wool, etc., are clearly dealt with. Whilst the book will be of the greatest value to those for whom it is primarily intended, namely, students of agriculture in the United States, it will also be of interest to those who have to deal with similar problems in this country, as well as in other parts of the British Empire.

THE SCIENTIFIC PRINCIPLES OF PLANT PROTECTION. By Hubert Martin, M.Sc., A.R.C.Sc., A.I.C., with a foreword by Sir Daniel Hall, K.C.B., F.R.S. Pp. xii + 316, 8½ × 5½. (London: Edward Arnold & Co., 1928.) Price 21s.

In this book, which Sir Daniel Hall in his preface describes as the first introduction to the general theory of plant hygiene that has appeared in English, the author has had before him the fact that the problems arising from the control of plant pests and diseases involve not only biological questions but equally important chemical and physical considerations, and that for rapid and successful progress in plant protection co-operation between the mycologist, entomologist, chemist, physicist and plant physiologist is essential. Such co-operation implies a knowledge on the part of each of these workers of the point of view of the others, but there is little doubt that such mutual understanding has been hindered by the lack of some convenient, accessible source of information as

an alternative to a laborious reading of the vast literature of the subject. Mr. Martin's volume will certainly be welcomed as the desired handbook. His first object has been to help the co-operation of the biologists and other workers by a wider survey of the scientific principles underlying the methods of control of plant pests. He has also endeavoured to provide a book of reference on insecticides and fungicides for the teacher and student of agricultural chemistry, though no attempt has been made to give full practical details of methods actually employed in the field since such information is dealt with in special literature and is often applicable only to the countries where the specific methods are successfully practised.

The book contains a great deal of subject-matter arranged in sixteen chapters which are divided into short headed sections which makes for ready reference and easy and pleasant reading. Plant resistance, involving a discussion of the production of resistant varieties by selection and hybridisation, is dealt with in association with the influence of external factors on the susceptibility of the plant to attack by its enemies ; while a series of chapters deal with the action of the various classes of fungicides and insecticides (stomach and contact poisons). The important question of fumigants is dealt with, and also the sterilisation of seeds by the mechanical, chemical and physical methods (heat), and the treatment of soils. The chapter on " biological control " of pests is an interesting account of examples of such methods rather than a discussion of the technical aspects of the question, but it forms a natural complement to the chemical and physical sections of the book. The concluding chapter comprises an original consideration of methods which deal more directly and intimately with the restriction of the spread of plant pests by the elimination of infection centres and by measures taken in regard to the carriers concerned in that spread. The book is admirably arranged for the student and is abreast of recent developments as evidenced by the references to Derris and Tephrosia as contact insecticides ; each section is provided with a short bibliography of important papers and there is an index of authors in addition to a general subject index.

AGRICULTURAL ENTOMOLOGY. By D. H. Robinson, B.Sc., and S. G. Jary, B.A. Pp. xi + 314,  $7\frac{3}{4} \times 5$ . (London : Gerald Duckworth & Co., Ltd., 1929.) Price 15s.

This volume should be of considerable value to agriculturists and others who wish to possess a sufficient knowledge of the morphology, physiology and habits of insects

for a proper understanding of the rationale of insect control. It presupposes no knowledge of entomology, and in the first part of the book the subject is approached in the classical manner by an examination of the structure and life histories of typical insects. The second part is an "economic section" in which the principal British insects of economic importance are dealt with under their respective orders, consideration being given to their habits, the plants affected and damage done by them, and the methods of control. Three appendixes treat of animal pests that are not insects but resemble insects in the incidence of their damage.

The book is written principally for those concerned with agriculture in the British Isles and does not deal with purely tropical pests, though its perusal can hardly fail to be of profit to all proposing to embark on agriculture or planting in any part of the Empire.

ALFALFA. By J. F. Cox and C. R. Megee. Pp. xi + 101, 8 × 5½. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1928.) Price 7s. 6d.

This practical and well-illustrated little manual is a useful addition to the literature of one of the most valuable of fodder crops. The authors state that the book has been prepared in response to a demand from farmers and teachers of agriculture in the United States for more explicit instructions and suggestions in regard to the growing of alfalfa (lucerne) than is usually included in a volume dealing generally with a number of crops. The information supplied should be of great help to both classes of agricultural workers. The first chapter describes the great value of alfalfa in farming practice if the crop is used to best advantage. The importance of the plant as a forage for livestock, and the increase in the production of meat and milk resulting from its use, are discussed, and attention is drawn to the improvement effected in the soil on which the crop is grown. The cultivation of alfalfa in the United States following the end of the war contributed largely to the improvement of agricultural conditions in the corn belt of the northern and eastern states, and it is expected that a greatly increased use of the crop will be permanently established in consequence.

The book covers all aspects of the subject. The selection of seed and the preparation and manuring of the soil are discussed; there are practical directions for planting and for the cutting, curing and storing of the crop. The use of the fodder in the nutrition of stock is

dealt with in a special chapter, and others are concerned with the growing of alfalfa in rotation, and the production and marketing of seed. Directions are also given for the control of the principal diseases and pests of the plant.

**FRUIT-GROWING IN SOUTH AFRICA.** By R. A. Davis. Pp. 532,  $8\frac{1}{2} \times 5\frac{1}{2}$ . (South Africa : Central News Agency, Ltd., 1928.) Price 27s. 6d.

It was not till nearly the end of last century that fruit growing in South Africa began to develop into an industry of any importance. It may, in fact, be dated from the year 1892, when Mr. H. E. V. Pickstone, who had been impressed with the fruit-growing possibilities of the country and had gained a good knowledge of nursery business in California, returned to South Africa and induced Mr. Cecil Rhodes to become interested in the subject. That the enterprise was well founded is proved by the subsequent history of the South African fruit industry.

This book is likely to be of considerable value to all who propose embarking on fruit growing in South Africa as a career. They will find in it an exposition of the general principles of orcharding, with discussions of the climatic conditions and soils in different parts of the Union ; a succession of chapters dealing with individual fruits, their cultivation, varieties, etc. ; and other chapters devoted to the export of fruit, including the intricacies of packing, as well as to that important branch of the industry, the production of dried fruit.

In considering the marketing of South African fruit in this country, stress is laid on the results of the "eat more fruit" campaign and of the propaganda in favour of Empire fruit, and it may be noted that the author puts in a plea for more "reciprocity" by the purchase of British-made agricultural machinery, motor cars and other things at present so largely imported from the United States.

An index would have been a useful addition to the book.

**ARTIFICIAL SILK.** By Dr. O. Faust, translated from the German by Ernest Fyleman, B.Sc., Ph.D., F.I.C. Pp. vii + 184,  $8\frac{1}{2} \times 5\frac{1}{2}$ . (London : Sir Isaac Pitman & Sons, Ltd., 1929.) Price 10s. 6d.

The rapid growth of the artificial silk industry and its increasing technical and commercial importance have led to the publication of a number of books on the subject, several of which have already been noticed in this BULLETIN. In the present work, after a short historical

introduction, the subject-matter is divided into two parts, a general section and a technical section. The former contains a discussion of the chemical and physical properties of the spinning solution, and of the fibres produced and the methods of their scientific investigation, special attention being devoted to the structure of cellulose and of artificial silk fibres as revealed by X-ray analysis and other methods, and to the study of swelling power.

In the technical section the author describes the raw materials of the industry, spinning processes and apparatus, after-treatment processes, and the manufacture of nitrate, acetate, cellulose ether, cuprammonium and viscose silk, and detailed information is provided with regard to the character of the spinning process (and more particularly of the stretch-spinning process), and the ripening of viscose.

The last chapter supplies statistics of production and consumption of artificial silk, and a bibliography is appended.

MODERN PAPER-MAKING. By Robert Henderson Clapperton and William Henderson. Pp. xiv + 365, 9 $\frac{3}{4}$  × 7 $\frac{1}{4}$ . (London: Ernest Benn, Ltd., 1929.) Price 31s. 6d.

The authors, in this addition to the literature of paper-making, present a concise and comprehensive review of modern paper manufacture.

The book contains twenty-four chapters, which are so arranged that the manufacture of paper is followed from the collection of the raw materials through the different stages of preparation to the finished product, descriptions being given of the chemicals employed and of the methods of soda recovery.

A quantity of very useful information is given in the sections dealing with the treatment of esparto grass and rags, and the subsequent manufacture of paper from them. It is, however, to be regretted that the information on the acid sulphite and soda processes should be so scanty. Three chapters are devoted to the Fourdrinier machine, which is dealt with in an exhaustive manner. There is also an excellent chapter on newsprint. Owing to the enormous consumption of paper of this variety, the modern methods of manufacture of newsprint and cheap printing papers regarded from the engineering aspect have developed during the last twenty-five years to a highly specialised and technical system, and in this respect the manufacture of newsprint differs from paper-making as generally described. This subject, which is treated in a rather cursory manner in most textbooks, is here accorded

a complete review, the details being arranged in a practical manner.

An authoritative account of the manufacture of hand-made paper by Mr. J. B. Green, of Hayle Mill, Maidstone, and a chapter on the Fractional Digestion of Bamboo by Mr. W. Raitt, F.C.S., M.I.Chem.E., are included.

Having regard to the complicated engineering and mechanical side of paper-making the authors have succeeded in presenting this difficult subject with its recent improvements in a very readable manner.

A useful appendix of Tables and Paper Trade Customs is given, together with appendixes on the Rabus beater and the "Mould" machine. There is also a good large-scale diagram of a Fourdrinier machine, with sectionalised electric drive.

The book is well arranged and contains a large number of illustrations representative of processes and machinery.

This book should be of value to students and mill workers generally as a useful source of reference, and should encourage a detailed and scientific study of paper-making.

CITRONELLA-OLIE. By H. W. Hofstede. *Mededeelingen van de Afdeeling Nijverheid*, No. 4, *Department van Landbouw, Nijverheid en Handel*. Pp. vi + 189,  $9\frac{1}{2} \times 6\frac{3}{4}$ . (Buitenzorg : Archipel Drukkerij, 1928.) Price 8.50. fr.

The author in this treatise deals comprehensively with the production of citronella grass oil in the Netherlands East Indies. He commences by giving a short account of the history of the industry, and discusses the differences between Java and Ceylon citronella grass oils. Particulars are given concerning the formation and distribution of the oil in the plant, and its composition. Much useful information is included on the laying out of a plantation, selection of plants, conditions of growth, methods of planting, maintenance of a plantation, the diseases of the plant, its manuring, harvesting and yields.

The question of the steam distillation of the grass is dealt with fully. Types of steam stills, and those in which direct firing is employed, are described with the aid of diagrams; and the results obtained by both methods are recorded. Information is also given regarding the method of preparing the grass for distillation, and the effect on the yield and quality of the oil of cutting the plants at various ages and in the wet and dry seasons.

Reference is made to the solubility of the oil in water, and its composition throughout the period of the distillation. It is noted that the percentage of total geraniol in the oil gradually decreases as the distillation progresses.

Special attention is drawn to methods of condensing the oil and water vapour, and their influence on the yield and quality of the oil. Other matters dealt with include the collection and packing of the oil, the uses of the exhausted grass, costs of production, selling conditions, methods of analysis, adulteration of the oil, its uses, and statistics of production and export from the Netherlands Indies, and the prospects of the industry. The book is well illustrated and contains a useful bibliography.

THE CHEMISTRY OF LEATHER MANUFACTURE. Vol. I. Second Edition. By John Arthur Wilson. Pp. 495, 9 x 6. (New York: The Chemical Catalog Co., Inc., 1928.) Price \$10.00.

The chemistry of leather is exceptionally difficult. It deals with the proteins and the tannins; with the enzymes, bacteria and moulds; with involved problems of colloidal and physical chemistry; with mordants, dyestuffs, gums, resins and other complex materials. Our knowledge of many of the basic problems in pure science upon which all advances in the technology of leather manufacture must necessarily be built, is, at present, very meagre. Yet it is only when these fundamental problems have been solved that the craft of leather-making can develop into a scientifically controlled operation. At present the most promising advances in the chemistry of leather have been the result of the successful application of the methods of physical chemistry. In the book under review, which has now, on reaching its second edition, been expanded into two volumes, considerable attention has been paid to this side of the subject.

The opening chapter deals with the histology of the skin, and shows with the help of an excellent series of photomicrographs how most of the important properties of leather depend on the structure of the skin from which it is made. Following an account of the chemical constituents of skin come two chapters on the physical chemistry of the subject. Chapter VI contains a brief account of the bacteria, moulds and yeasts most commonly met with in the tannery, together with a very short note on enzymes. The preservation and disinfection of skins, the processes of soaking and fleshing, of unhairing and scudding, of bating, and of drenching and pickling are each described and discussed in successive chapters.

The last three chapters are devoted to the vegetable tanning materials. A list of natural tanning materials is given, showing, in each case, the source of the material and its tannin content, and a few of the more important

materials are briefly described. Methods of leaching and various factors affecting the process are discussed. The evaluation of tanning materials and the chemistry of the tannins are also dealt with.

**LIVESTOCK HUSBANDRY ON RANGE AND PASTURE.** By Arthur W. Sampson, M.A., Ph.D., Assistant Professor of Range Management, University of California. Pp. xxi + 411, 9 × 5½. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1928.) Price 22s. 6d.

In the author's words, this volume is "intended principally to provide systematic instruction for those who wish to train themselves as range technicians and for those who intend to engage in livestock raising." It is divided into four parts, dealing respectively with "Range History and Livestock Improvement"; "Pasture Husbandry of Sheep and Goats"; "Pasture Husbandry of Beef Cattle"; and "Economics of Pasture Livestock." The second part is the longest of the four and deals mainly with sheep, much useful information being furnished regarding the various breeds and the raising and general handling of sheep on the farm, both for wool and mutton. Beef cattle are dealt with in the following section. The volume is copiously furnished with illustrations, bibliographies, and sets of test questions for the student, and the general style of the letterpress is concise and readable.

**DAIRY BACTERIOLOGY.** By Bernard W. Hammer, Ph.D. Pp. xii + 473, 9 × 5½. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1928.) Price 25s.

The subject-matter of this volume is that of a course of lectures on dairy bacteriology given at Iowa State College. It deals with its subject from the point of view of the practical scientific worker, but it is considerably more than a "laboratory companion." It is likely to be of value both to the dairy industry and to those engaged in dairy husbandry. Some knowledge of general bacteriology on the part of readers is presupposed.

**THE VISCOSITY OF LIQUIDS.** By Emil Hatschek. Pp. xii + 239, 8½ × 5½. (London: G. Bell & Sons, Ltd., 1928.) Price 15s.

The subject of viscosity has hitherto proved of considerable difficulty to students of colloid chemistry, especially owing to the lack of any single book giving a general view of this branch of physics.

The present work has therefore been written with a view to the presentation of the fundamental principles of the subject within a moderate compass and without any excessive application of mathematics. A special chapter is devoted to the viscosity of colloidal solutions since, in the words of the author, this is "a subject of peculiar difficulty calling for a great deal of further research, which a summary of the present position may perhaps help to stimulate."

The book contains numerous references to original papers and is furnished with many excellent diagrams.

AN INTRODUCTION TO THE STUDY OF ORE DEPOSITS. By F. H. Hatch, O.B.E., Ph.D. Pp. 117,  $8\frac{1}{2} \times 5\frac{1}{4}$ . (London: George Allen & Unwin, Ltd., 1929.) Price 7s. 6d.

This little book is founded on a course of lectures given at Cambridge some years ago, these having been revised and brought into line with more recent work. The opening chapter gives a brief historical summary of the theories of ore deposition, and serves to show that this subject still remains a highly controversial one, in spite of its long scientific history.

The genetic-geological principle is accepted by the author as the proper basis of treatment, separate chapters being given to genesis by segregation in basic magmas, gaseous emanations from granitic magmas, gaseous emanations connected with volcanic eruptions, and thermal waters in which are included waters of surface origin as well as those of igneous origin.

Other chapters are given to the alteration of ore deposits (including secondary enrichment), ore formation by mechanical agencies, residual deposits and chemical precipitation in surface waters.

By way of contrast with the genetic basis of treatment that governs the main part of the book, a final chapter is given to the morphological basis of treatment, in which deposits are distinguished as *tabular* and *non-tabular*, instances of various types being cited.

The book is well illustrated and indexed, and can be recommended as a useful introduction to the study of a very interesting subject.

TIN: SALIENT FACTS AND OPINIONS. By J. A. L. Gallard and Murray Stuart, D.Sc., Ph.D., etc. Pp. 46,  $7\frac{1}{4} \times 4\frac{3}{4}$ . (London: Mining Publications, Ltd., 1929.) Price 2s. 6d.

This little book is a compendium of some of the more important facts and opinions relative to the tin industry,

and deals cursorily with such subjects as the uses of tin, consumption and prospects, future supplies, stabilisation, origin and exploitation, output and cost factors, tin statistics, etc.

The possibilities of remunerative investment in shares of tin-producing and allied finance companies are illustrated by some striking figures relating to half a dozen of the best-known British-controlled undertakings.

The work is necessarily of a somewhat sketchy nature, but can be recommended to anyone desiring a rapid, yet accurate, survey of the industry at a modest cost.

EARTH FLEXURES. By H. G. Busk, M.A., F.G.S., F.R.G.S. Pp. vi + 106,  $9\frac{1}{2} \times 7\frac{1}{4}$ . (Cambridge and London: Cambridge University Press, 1929.) Price 12s. 6d.

This is the first textbook on the application of geometric methods to the study of geological maps and sections. Its object is to show how the information obtainable from geological maps may be best applied, how geometric methods for section-drawing of folds may be used, and what pitfalls beset the worker. As it is not a treatise on the elements of field-mapping and section-drawing, the student would be well advised to acquaint himself with some standard work on these subjects, such as the admirable publication in this series, *The Study of Geological Maps*, by Gertrude L. Elles, D.Sc. (Cambridge University Press, price 12s.).

The present work is based on the fundamental principle that all curves may be divided into a number of tangential arcs, the graphical method being retained for the sake of simplicity.

After a brief introduction and a chapter on sedimentation and folding, the author advances a number of tectonic definitions to replace those generally but loosely applied. Chapter III consists of fourteen propositions relating to the geometrical construction of earth flexures in geological sections. This is followed by an account showing how to determine the "axial plane" of a fold. Chapter V deals with geological mapping in connection with accurate section-drawing, including an account of plane-table surveying. A concluding chapter describes the Tertiary flexures in the petroliferous rocks of Burmah, south-west Persia, and the west coast of the Sinai Peninsula.

The book is well provided with diagrams, and should prove particularly interesting to the mathematically inclined oil geologist, while at the same time it should prove useful in helping him to reduce the risks of wild-cat drilling.

LOW-TEMPERATURE CARBONIZATION (OR DISTILLATION) EXPLAINED. By Murray Stuart, D.Sc., Ph.D., etc. Pp. 57,  $8\frac{3}{4} \times 5\frac{1}{2}$ . (London : Mining Publications, Ltd., 1929.) Price 4s.

Low-temperature distillation is a revival of an industry which was originated through the researches of James Young in 1848 to 1851, and was established with the object of producing thick lubricating and lamp oils by the low-temperature distillation, firstly of petroleum from a seepage at Alfreton, Derbyshire, and, afterwards, from various coals—parrot, cannel, boghead, etc. The industry thrived in Great Britain, Germany and the United States until the advent of the petroleum era in 1859, after which it disappeared almost completely. The main object of the present-day form of the process is the production of smokeless fuel, while that of the high-temperature distillation process is the production of gas at gas-works or of hard-smelting coke at gas-ovens. The two processes are entirely distinct and do not encroach upon each other. While gas is produced usually near the point of consumption, low-temperature plants, as is pointed out in this book, should be worked at the pithead.

The author is specially qualified for writing the book, having had considerable experience with coal-distillation. The book is not very technical, but, as its title suggests, it contains just enough technical information for the ordinary reader to understand and profit by. It also gives a warning to would-be investors not to be misled by the propaganda put forward on behalf of some of the processes now being advertised. Expert advice should always be obtained.

Notwithstanding this warning, the author definitely states that, generally speaking, low-temperature distillation is a profitable undertaking, although in some cases it may be a commercial failure. Any particular method to be applied must be suited to the coal to be used and its cost. The author quotes as a successful application the experience of the Newcastle Electric Power Company's plant at Dunston, where coal costing 12s. per ton (in 1928) was distilled yielding by-products worth 10s. 6d. and semi-coke of value 9s. 1d. per ton of raw coal. The total operating expenses being 4s. 8d., a profit of about 3s. per ton is indicated. The semi-coke in pulverised form is used in the boilers of the generating plant. The author shows that with similar conditions if the coal had cost 6s. per ton the semi-coke could have been delivered to the boilers at no cost, or if 24s. had been the price there would have been no profit from the distillation plant.

The author gives short descriptions of sixteen low-temperature distillation plants in Great Britain, which are either operating continuously or have been tested on a working scale, as well as a table giving results from the working of eleven different plants. The value of the book is enhanced by a short selected bibliography on low-temperature distillation processes, and the author has performed a useful service in writing it.

AFRICAN MANUAL ON MINING, INDUSTRY AND AGRICULTURE. Edited by C. Carlyle-Gall. Pp. clxiii + 1319,  $8\frac{1}{2} \times 5\frac{1}{2}$ . (London and Johannesburg: Mining and Industrial Publications of Africa, Ltd.) Price 21s. (with map) Inland Post Free; 23s. (with map) Overseas Post Free.

This book, which is a revised and greatly enlarged edition of a work already well known, is a veritable mine of information on the Union of South Africa, Southern Rhodesia, Northern Rhodesia and Portuguese East Africa, and no one at all interested in Southern Africa can afford to be without it. Naturally a large proportion of the book is devoted to mining, full information being given with reference to each country on the industry as a whole, on the mineral resources, on the very numerous individual coal, metal and non-metal mines which are scattered over a huge area, as well as their production and prospects for future development. Agriculture, especially as regards its development and the production of maize, tobacco and cotton, also the raising of cattle and other livestock, and dairy farming in the various parts of the country, are fully described. In addition to these matters, the various industries which have been established are dealt with. Special sections are devoted to information for tourists and prospective settlers, railway and other systems of communication, mining, game and other laws, banking, sport and amusements, and steamship lines trading with Southern Africa.

## BOOKS RECEIVED FOR NOTICE

CORN AND CORN GROWING. By Henry A. Wallace and Earl N. Bressman. Pp. vii + 371,  $8 \times 5\frac{1}{2}$ . Third edition. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1928.) Price 12s. 6d.

SUGAR CANE AND ITS CULTURE. By F. S. Earle. Pp. vii + 355,  $9 \times 5\frac{1}{2}$ . (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1928.) Price 22s. 6d.

SUGAR BEET IN FRANCE, BELGIUM, HOLLAND AND GERMANY. By A. Bridges and R. N. Dixey. Pp. 119,  $8\frac{1}{2} \times 5\frac{1}{2}$ . (Oxford: The Clarendon Press, 1928.) Price 4s. 6d.

ÖLPALME. By Prof. Dr. E. Fickendey and H. N. Blommendaal. Bangerts Auslandbücherei, No. 35. Reihe: Wohltmann-Bücher, Monographien zur Landwirtschaft warmer Länder, Band 7. Pp. vi + 211,  $7 \times 4\frac{3}{4}$ . (Hamburg and Leipzig: Deutscher Auslandverlag Walter Bangert, 1929.) Price RM.9.

FRUIT PECTIN: ITS COMMERCIAL MANUFACTURE AND USES. By William A. Rooker. Pp. ix + 170,  $7\frac{1}{4} \times 5$ . (New York: Avi Publishing Co., Inc., 1928.) Price 26s.

AMERICAN SOAP MAKER'S GUIDE. By I. V. Stanley Stanislaus and P. B. Meerbott. Pp. xi + 709,  $9\frac{1}{4} \times 6$ . (London: Chapman & Hall, Ltd., 1929.) Price 50s.

DIRECTORY OF PAPER MAKERS OF GREAT BRITAIN AND IRELAND FOR 1929. Pp. 276,  $10\frac{1}{4} \times 7\frac{1}{4}$ . (London: Marchant Singer & Co., 1929.) Price 5s.

THE PRACTICE OF SILVICULTURE. By Ralph C. Hawley. Second edition. Pp. xiii + 335,  $9 \times 6$ . (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1929.) Price 20s.

LES CACTACÉES UTILES DU MEXIQUE. By Léon Diguët. Pp. 551,  $10 \times 6\frac{1}{2}$ . (Paris: Société Nationale d'Acclimatation de France, 1928.) Price F.120.

MINERALS IN PASTURE AND THEIR RELATION TO ANIMAL NUTRITION. By J. B. Orr, D.S.O., M.C., M.A., D.Sc., M.D., with the assistance of Helen Scherbatoff. Pp. xv + 150,  $9\frac{3}{4} \times 6$ . (London: H. K. Lewis & Co., Ltd., 1929.) Price 10s. 6d.

PATTERNS FOR A SERIES OF TWELVE BLOCK MODELS ILLUSTRATING GEOLOGICAL STRUCTURES WITH DESCRIPTIVE NOTES. By Frank Smithson, Ph.D., F.G.S. (London: Thomas Murby & Co.; New York: D. van Nostrand Co., 1929.) Price 1s. 6d. per set.

# REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

*Selected from the Reports made to the Dominion, Colonial  
and Indian Governments*

## RECENT INVESTIGATIONS OF OIL SEEDS

IN the following pages an account is given of the results of examination of certain new or little known oil seeds which have been received recently at the Imperial Institute. The materials dealt with comprise perilla seed (*Perilla ocymoides*) from Assam ; perilla oil (*Perilla nankinensis*) from Manchuria ; oiticica nuts (*Licania rigida*) from Brazil ; mlenda seed (*Sesamum angustifolium*) from Tanganyika ; kullan nuts (*Balanites orbicularis*) from British Somaliland ; and babassu fruits and kernels (*Orbignia Martiana*) from Brazil.

### I. PERILLA SEED AND OIL

Two samples of perilla seed were forwarded to the Imperial Institute by Mr. H. C. Sampson, Royal Botanic Gardens, Kew, to whom they had been supplied by the Agricultural Adviser to the Government of India as representing two varieties grown in Assam. On examination of the seed in the Herbarium at Kew it had been found to agree with that of *Perilla ocymoides*.

A sample of perilla oil has also been supplied to the Imperial Institute by Dr. L. A. Jordan, who had received it from Manchuria. Dr. Jordan has furnished a sample of the seed yielding the oil to the Royal Botanic Gardens, Kew, where it has been identified as *Perilla nankinensis*.

The two samples of seed from Assam were found to contain the following amounts of moisture and oil :

	White variety. Per cent.	Black variety. Per cent.
Moisture . . . . .	5·6	5·5
Oil, in seed as received . . . . .	2·7	43·8
Oil, expressed on the moisture-free seed . . . . .	45·2	46·4

	Oil of <i>P. ocymoides</i> .				Oil of <i>P. nankinensis</i> .		Commercial Perilla Oil.	
	Present samples.		Previous samples.		Sample from Manchuria.	Recorded figures.	Usual limits.	United States specification.
	"White."	"Black."	From Assam.	From all sources.				
—	0.9350 1.475 1.2 192.6 198.0 0.9	0.9344 1.475 2.3 192.6 196.8 1.1	0.9308-0.9339 — 5.1-28.1 194.7-197.6 189-193 —	0.9298-0.9339 1.472-1.476 1.4-28.1 189.2-197.6 175.4-193 0.7-1.5	0.9348 1.474 2.6 192.9 192.6 0.9	0.932 1.4780 4.3 193.4 193.3 —	0.932-0.936 1.4748-1.4754 1.0-6.0 189-193 195-205 1.0-1.3	0.932 (min.) — 5.0 (max.) 190 (min.) 191 (min.) 1.5 (max.)
	Specific gravity at 15/15° C.							
	Refractive index at 40° C.							
	Acid value							
	Saponification value.							
	Iodine value (Hübl, 17 hrs.)							
	Unsataponifiable matter							
	per cent.							
	per cent.							

Previous samples of *P. ocymoides* seed examined at the Imperial Institute from Assam yielded 44.7 to 49.1 and from other sources 38.5 to 47.3 per cent. of oil, expressed on the moisture-free seed.

The oils, extracted with light petroleum from these samples, had the characteristic odour of perilla oil and were of a golden-yellow colour, that of the oil from the "black" variety being slightly deeper than that of the oil from the "white" variety.

The sample of oil from *P. nankinensis* seed from Manchuria was a clear, golden-brown oil with a characteristic odour and free from "foots."

These three oils were examined with the results shown in the table herewith, to which are added for comparison the corresponding figures obtained at the Imperial Institute for previous samples of the oil of *P. ocymoides*, the recorded figures for commercial perilla oil and the requirements of the United States specification for perilla oil.

The results of the examination show:

(1) That the present samples of seed from Assam

contain similar amounts of oil to the previous ones from that country and the oils extracted from them have similar constants to those previously obtained for oil from Assam seed.

(2) That the present samples from Assam contain a normal percentage of oil.

(3) That the oils extracted from them have constants similar to those previously found at the Imperial Institute for the oil of *P. ocymoides* and to those of commercial perilla oil.

(4) That the oil of *P. nankinensis* yields analytical figures similar to those previously recorded for this oil and to those for *P. ocymoides* oil and for commercial perilla oil.

(5) That the oils from both varieties of perilla seed meet the requirements of the United States specification for perilla oil.

## 2. OITICICA NUTS (*LICANIA RIGIDA*)

Two samples of the Brazilian oil seed known as oiticica have been received recently. One sample, consisting of the whole nuts, was forwarded by Dr. E. Teixeira, of Rio de Janeiro, who stated that they were collected in the State of Rio Grande do Norte, where the trees are abundant, and the other, consisting of kernels representing a consignment of 5 tons imported from Brazil, was sent by a firm of importers. The latter firm also forwarded for examination a sample of oil expressed by a firm of oil-seed crushers from the consignment of kernels.

Dr. Teixeira informed the Imperial Institute that the fruits he sent were derived from *Licania rigida* Benth., a plant belonging to the natural order Rosaceæ; Bolton and Revis, in a paper recording the results of examination of oiticica oil, published in the *Analyst* (1918, 43, 251), give the source of the kernels they examined as *Couepia grandiflora*, a member of the same family.

The sample received from Dr. Teixeira consisted of long, oval nuts of buff colour, measuring from 1.2 to 1.9 in. in length and from 0.5 to 0.8 in. in diameter at the widest part. Many of the nuts were wholly or partly covered with green dried pulp. The nuts had a thin

fibrous brittle shell, enclosing one kernel. The kernels were 0.9 to 1.6 in. in length and 0.4 to 0.7 in. in diameter at the widest part. They were fairly soft, of dark reddish-brown colour with numerous white veins; and separated more or less readily into two cotyledons.

The nuts consisted of shell 26 per cent. and kernel 74 per cent. The nuts averaged 4.4 grams and the kernels 3.2 grams in weight.

The kernels taken from the consignment imported from Brazil were similar in size and appearance to those contained in the nuts sent by Dr. Teixeira.

The moisture content and the yield of oil obtained on extraction with light petroleum of the two samples of kernels were found to be as follows:

	I. Kernels from nuts.	II. Kernels as imported.
Moisture . . . . .	4.8	4.7
Oil, in kernels as received. . . .	60.8	62.7
Oil, expressed on moisture-free kernels	63.9	65.8

The oil, as extracted from the kernels at the Imperial Institute with light petroleum, was in each case partly a golden-yellow liquid and partly a white solid, whilst that expressed from imported kernels by a firm of oil-seed crushers was a cream-coloured fat of soft consistency. The latter was free from moisture and "foots" and on melting the oil formed a clear transparent liquid.

The oils examined at the Imperial Institute were found to have the following constants, which are shown in comparison with the corresponding figures recorded by Bolton and Revis for oiticica oil (*Analyst*, 1918, 43, 251).

	Oils examined at Imperial Institute.			Oil recorded by Bolton and Revis.
	I. Extracted from kernels obtained from nuts.	II. Extracted from imported kernels.	III. Expressed by oil-seed crushers.	
Specific gravity at 15/15° C. . . .	0.9675	0.9673	0.9679	0.9694
Refractive Index at 40° C. . . . .	1.5069	1.507	1.504	—
Acid value . . . . .	1.8	5.6	4.4	11.4
Saponification value . . . . .	189.5	186.1	190.8	188.6
Iodine value (Wijs, 3 hrs.) <i>per cent.</i>	140.5	144.8	139.0	179.5
Unsaponifiable matter <i>per cent.</i>	0.5	0.9	0.9	0.91
Solidifying point of fatty acids . .	47.4° C.	45.4° C.	44.8° C.	42.8° C.

In the case of each of the oils examined at the Imperial Institute, it was found that on heating the oil small bubbles of gas were evolved at  $190^{\circ}\text{C}$ . which increased in size as the temperature rose. When kept at  $250^{\circ}$ – $270^{\circ}\text{C}$ . for 30 minutes the oil did not polymerise, but when the temperature was slowly raised above this point the oil polymerised at  $300^{\circ}\text{C}$ . to a clear, transparent, stiff jelly. In the case of the oil expressed by oil-seed crushers the polymerisation at this temperature took rather longer than in the case of the other two samples of oil, but otherwise their behaviour on heating was the same.

The results of the examination show that the kernels examined contained a normal percentage of oil of the usual appearance. The average yield of oil previously recorded is about 62 per cent.

A comparison of the figures with those recorded by Bolton and Revis shows that the solidifying point of the fatty acids of the oils examined at the Imperial Institute was from 2 to 4.6 degrees above that previously recorded, whilst the iodine value of the oils is about 35–40 per cent. below the recorded figure. It does not appear that this difference can be due to oxidation of the oil during its preparation as every precaution was taken to prevent access of air.

The oil on heating behaved similarly to that examined by Bolton and Revis, and in this respect resembles tung oil.

### 3. MLEND A SEED (*SESAMUM ANGUSTIFOLIUM*)

The seed of a plant known by the native name of "Mlenda" was forwarded to the Imperial Institute recently by the Entomologist to the Department of Agriculture, Tanganyika. The plant, which has been identified from herbarium specimens sent to the Royal Botanic Gardens, Kew, as *Sesamum angustifolium* Engl., is grown by the Wanyamweji and Wasakuma peoples for its leaves, which are eaten as a green vegetable.

The sample received consisted of very small oval seeds with pitted seed-coats. They were mostly very dark brown or almost black, whilst some were pale reddish-brown.

The seeds contained 7.5 per cent. of moisture and on extraction with light petroleum furnished 28.9 per cent. of oil, corresponding to a yield of 31.2 per cent. from the moisture-free seeds.

The oil thus extracted was a pale green, limpid liquid, which gave a very slight deposit on standing. It was examined with the results given in the following table, where they are compared with those recorded for commercial sesame oil (from *Sesamum indicum*).

	Present sample of oil.	Commercial sesame oil. <sup>1</sup>
Specific gravity at 15/15° C. . . . .	0.9365	0.922-0.924
Acid value . . . . .	16.8	2-10
Saponification value . . . . .	181.6	188-193
Iodine value (Hübl, 17 hrs.) . . . . .	117.7	103-112
Refractive index at 40° C. . . . .	1.4708	1.4653-1.4663

<sup>1</sup> Bolton, *Oils, Fats and Fatty Foods*, p. 290.

The oil resembled commercial sesame oil in giving a reaction with Baudouin's reagent.

The meal left after the extraction of the seeds with light petroleum was dark grey and tasteless. Indications were obtained of the presence of a substance giving reactions characteristic of alkaloids.

The results of the analysis of the meal are given below in comparison with those furnished by commercial sesame cake.

—	Present sample.		
	As prepared.	Calculated to contain 7 per cent. fat.	Commercial sesame cake. <sup>1</sup>
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Moisture . . . . .	8.0	7.5	8.12
Crude proteins . . . . .	23.8	22.2	39.60
Fat . . . . .	0.3	7.0	13.01
Carbohydrates, etc. (by difference) . . . . .	18.5	17.2	22.00
Crude fibre . . . . .	42.8	39.9	4.36
Ash . . . . .	6.6	6.2	12.91
Nutrient ratio . . . . .	1 : 0.8	1 : 1.5	1 : 1.31
Food units . . . . .	79	90	154

<sup>1</sup> *Average of recorded analyses.*

From the foregoing results the composition of the original seed was calculated as follows :

	Per cent.
Moisture . . . . .	7.5
Crude proteins . . . . .	16.5
Fat . . . . .	28.9
Carbohydrates, etc. (by difference) . . . . .	12.8
Crude fibre . . . . .	29.7
Ash . . . . .	4.6
Nutrient ratio . . . . .	1:4.8
Food units . . . . .	126

This sample of " Mlenda " seed differs in appearance from the ordinary sesame seed of commerce (*Sesamum indicum*) in having a pitted seed-coat. The seeds contain only 28.9 per cent. of oil, whereas commercial sesame seed usually yields from 48 to 54 per cent. The oil extracted from the *S. angustifolium* seeds gives constants similar to those of commercial sesame oil, and also responds to the Baudouin test.

The composition of the residual meal differs considerably from that of commercial sesame cake in containing much less protein and a very large proportion of fibre.

The Mlenda seeds would probably not realise more than about £9 to £10 per ton in London, owing to the low percentage of oil and the inferior quality of the oil cake. The latter contains a considerable quantity of protein, but its value as a feeding-stuff is greatly reduced by the large proportion of fibre present. In any case, before being used as a cattle food it would be necessary to ascertain by preliminary feeding trials that it would be innocuous. Should it be found that the cake could not be satisfactorily employed as a feeding-stuff it could be used as a manure.

The oil would be suitable for the manufacture of soap and, after being refined, could probably be also used as an edible oil. The crude oil for soap-making would probably be worth about £30 per ton in London, and the refined oil about £36 per ton. The oil would compete in the market with cotton-seed oil and possibly also with sesame oil, for which a considerable demand exists on the Continent.

The results of this investigation have shown that " Mlenda " seed, although furnishing an oil resembling ordinary sesame oil in character, would be of comparatively low value owing to the fact that it contains only 28.9 per

cent. of oil and yields an oil cake of poor quality owing to the presence of a very large amount of fibre. The seed could not compete with ordinary sesame and its production for export could not be recommended.

#### 4. KULLAN NUTS (*Balanites ORBICULARIS*),

The nuts which are the subject of this report were forwarded to the Imperial Institute by the Chief of Customs at Berbera, British Somaliland, together with specimens of the leaves and branches of the tree yielding them. The plant has been identified at the Royal Botanic Gardens, Kew, as *Balanites orbicularis* Sprague.

The sample consisted of oval nuts from  $\frac{3}{4}$  to  $1\frac{1}{4}$  in. long and  $\frac{1}{2}$  to  $\frac{3}{4}$  in. in diameter. The nuts had a pale brown, rough, thin, brittle, woody shell, and generally contained one kernel only, but in a few cases two or three kernels were present. The kernels were from  $\frac{1}{2}$  to  $\frac{3}{4}$  in. long and  $\frac{3}{8}$  to  $\frac{1}{2}$  in. in diameter. They were crinkled and light yellowish-brown externally, and hard and yellowish-brown within.

The average weight of the nuts was 2.1 grams, and that of the kernels 1.3 grams. The nuts consisted of shell 35.8 per cent. and kernel 64.2 per cent.

The kernels were found to contain 6.3 per cent. of moisture and to yield on extraction with light petroleum 37.2 per cent. of a clear, golden yellow, limpid oil, corresponding to a yield of 39.7 per cent. of oil from the moisture-free kernels.

The oil was found to have the following constants,

—	<i>Balanites orbicularis</i> oil.	<i>Balanites aegyptiaca</i> oil.		<i>Balanites Maughamsii</i> oil.
		(a)	(b)	(c)
Specific gravity at 15/15° C.	0.9184	0.919	0.9187	0.916
Refractive index at 40° C.	1.4623	—	—	—
Acid value	0.3	5.0	1.4	—
Saponification value.	192.7	196.7	194.2	198.5
Iodine value (Hübl, 17 hrs.)	—	—	—	—
Unsaponifiable matter per cent.	75.9	92.5	98.2	100
Solidifying point of fatty acids per cent.	0.5	0.6	—	—
Solidifying point of fatty acids	38.6° C.	34.6° C.	34° C.	—

(a) Oil received from Nigeria.

(b) Oil extracted from seeds received from the Sudan.

(c) Oil extracted from seeds received from Portuguese East Africa.

which are shown in comparison with the corresponding figures obtained at the Imperial Institute for the oils of *Balanites ægyptiaca* and *B. Maughamii*.

The residual meal left after extraction of the oil with light petroleum was of dark cream colour and possessed a bitter after-taste. On shaking with water it yielded a strong and persistent froth, indicating the presence of saponin. It was free from cyanogenetic glucosides, but gave reactions showing the presence of one or more substances of an alkaloidal character.

The meal was found to have the following composition :

	Meal as prepared. <i>Per cent.</i>	Calculated for meal containing 7 per cent. of oil. <i>Per cent.</i>
Moisture . . . . .	9·6	9·1
Crude proteins . . . . .	30·5	28·8
Oil . . . . .	1·4	7·0
Carbohydrates, etc. (by difference) . . . . .	50·4	47·4
Crude fibre . . . . .	3·7	3·5
Ash . . . . .	4·4	4·2
<hr/>		
Nutrient ratio . . . . .	1 : 1·8	1 : 2·2
Food units. . . . .	130	137

The foregoing results show that the kernels of the *B. orbicularis* nuts contained less oil than *B. ægyptiaca* kernels received at the Imperial Institute from Nigeria and the Sudan which yielded 58·7 and 41 per cent. of oil respectively, and also less than the figure recorded by Bolton (*Oils, Fats and Fatty Foods*, p. 214) for the oil content of *B. Maughamii* kernels, viz. 45·5 per cent. The oil of *B. orbicularis* is of a non-drying character, and has an iodine value considerably less than that recorded for the oils of *B. ægyptiaca* and *B. Maughamii*. The residual meal contains a considerable quantity of crude proteins, but its bitter after-taste and the presence of saponin and possibly also of substances of an alkaloidal nature, might preclude its use as a cattle-food in the United Kingdom, and in any case feeding trials would be necessary before it could be recommended for this purpose.

The oil from Kullan nuts could be employed in the United Kingdom for certain technical purposes, such as soap-making, and if refined it might be suitable for edible use. The crude oil would be worth about £30 per ton in London (November 1928), and the refined oil about £36

per ton. If the residual meal proved unsuitable for use as a feeding-stuff it could be utilised as a fertiliser, but for this purpose it would only be worth about £4 per ton in the United Kingdom. Even if trials showed that the meal would be innocuous for feeding purposes it would have to compete with more palatable products (such as linseed cake and cotton-seed cake) and would probably not realise more than £7 per ton.

The kernels would probably realise about £10 to £12 per ton in London (November 1928), the exact price depending on the value of the residual meal.

The Imperial Institute is making enquiries as to the possibility of collecting Kullan nuts in sufficient quantities for export, and it has been pointed out to the Somaliland authorities that it would be preferable to remove the shells in Somaliland and to ship only the dried kernels, of which consignments of 50 to 100 tons would be required to render them of commercial interest to oil-seed crushers.

#### 5. BABASSU FRUITS AND KERNELS (*ORBIGNIA MARTIANA*)

Specimens of various products, including fruits and kernels, derived from the Babassu palm (*Orbignia Martiana* Barb. Rodr. = *Attalea speciosa* Mart.) have been forwarded to the Imperial Institute by a Brazilian firm at the request of Dr. Eurico Teixeira.

The material consisted of two sets of specimens derived respectively from the Xingu River District, State of Para, and from the State of Amazonas.

(1) *Fruits*.—Four fruits were received from the Xingu River District. They were 4 in. long and 2½ in. in diameter at the widest part, oval in shape and of light-brown colour. The average weight was 202 grams. The fruits consisted of (a) a tough, fibrous husk, light brown externally and with a brown inner surface, (b) a pinkish-brown farinaceous layer about ¼ in. thick, (c) a thin layer of light brown, coarse, fairly stiff fibre, which surrounded (d) the nut, the shell of which was approximately ⅜ in. thick, woody and very hard. Of three fruits opened at the Imperial Institute two contained four kernels each, and the other contained five.

Four fruits were also received from the State of Amazonas. They were from  $4\frac{1}{4}$  to  $4\frac{3}{4}$  in. long and from 2 to  $2\frac{1}{2}$  in. in diameter at the widest part, and were rather narrower and longer than the fruits from the Xingu River District and not so regularly oval in shape. In colour they were dark brown. The average weight was 150 grams. The fruits consisted of (a) a tough fibrous husk, dark brown externally and with a brown inner surface, (b) a farinaceous layer, from  $\frac{1}{8}$  to  $\frac{1}{4}$  in. in thickness, rather browner than in the fruits from the Xingu River District, (c) a thin layer of coarse, brown, fairly stiff fibre, which surrounded (d) the nut, the shell of which was about  $\frac{3}{8}$  in. thick, woody and very hard. Of three fruits opened at the Imperial Institute two contained three kernels each and the other only two.

(2) *Kernels*.—The sample from the Xingu River District consisted of reddish-brown kernels, varying in length from 1.4 to 1.9 (mostly 1.6 to 1.7) in., and in diameter from 0.4 to 0.6 (mostly 0.5) in. at the widest part. The kernels were mostly chipped, but not badly, and showed some signs of insect attack. The average weight was 3.7 grams.

The kernels from the State of Amazonas were longer and thinner than those from the Xingu River District, and of dark brown colour. They varied in length from 1.3 to 2.1 (mostly 1.7 to 1.8) in., and in diameter from 0.4 to 0.7 (mostly 0.4 to 0.5) in. at the widest part. The average weight was 2.9 grams.

On extraction with light petroleum, both samples of kernels yielded creamy-white solid fats of the usual appearance and character of babassu fat, that obtained from the Xingu River sample having a slightly deeper tint than the other. The residual meals left after the removal of the fat were tasteless and buff-coloured, that from the State of Amazonas being slightly the darker of the two. The results of the examination of the kernels, and of the oil and residual meals obtained from them, are shown in the following table, together with the corresponding figures previously recorded for babassu kernels by Bray and Elliott of the Imperial Institute (*Analyst*, 1916, **41**, 298) and by Bolton (*Oils, Fats and Fatty Foods*, p. 173) :

—	From Xingu River District.	From State of Amazonas.	Figures recorded by :	
			Bray and Elliott.	Bolton.
Moisture in kernels as received <i>per cent.</i>	5.1	4.9	4.2	3-4
Oil in kernels as received <i>per cent.</i>	67.3	67.0	67.2	64.8-68.5
Oil in moisture-free kernels <i>per cent.</i>	70.9	70.5	70.1	—
<i>Constants of Oil.</i>				
Specific gravity at 100/15° C.	0.8672	0.8672	0.868	—
Melting point ° C.	24.1 <sup>1</sup>	25.4 <sup>1</sup>	26.0 <sup>1</sup>	21-22 <sup>2</sup> 24-26 <sup>3</sup>
Refractive index at 40° C.	1.450	1.450	—	1.4495-1.4506
Acid value . . .	3.5	1.8	5.5	1.0-10.0
Saponification value . . .	251.0	254.7	249.0	247-261
Iodine value, Wijs, 3 hrs. <i>per cent.</i>	13.4	9.7	—	14-16
Do., Hübl, 17 hrs. <i>per cent.</i>	13.0	9.4	15.6	—
Unsaponifiable matter <i>per cent.</i>	0.7	0.8	0.3	0.2-0.4
Solidifying point of fatty acids ° C.	21.4	21.1	23.0	23.0
Soluble volatile acids . . .	6.0	6.4	5.8	6.1
Insoluble volatile acids . . .	13.3	13.0	10.2	11.4
<i>Composition of Residual Meals</i> (expressed on meal contain- ing 7 per cent. of fat).				
Moisture . . . <i>per cent.</i>	10.8	10.5	8.5	10.3
Crude proteins . . <i>per cent.</i>	22.7	20.5	23.2	22.4
Fat . . . <i>per cent.</i>	7.0	7.0	7.0	7.0
Carbohydrates, etc. (by differ- ence) . . . <i>per cent.</i>	42.3	47.8	45.9	43.2
Crude fibre . . . <i>per cent.</i>	12.7	8.7	10.6	12.2
Ash . . . <i>per cent.</i>	4.5	5.5	4.8	4.9
Nutrient ratio . . .	1:2.6	1:3.1	1:2.7	1:2.6
Food units . . .	117	117	121	117

<sup>1</sup> Open tube method.<sup>2</sup> Incipient fusion.<sup>3</sup> Complete fusion.

The foregoing results show that the kernels from both samples contained normal amounts of oil of the usual character of babassu fat, and that the two oils had very similar constants, corresponding with those previously recorded, although slight differences were observable in the saponification and iodine values. The residual meals from the two samples were nearly identical in composition, the principal difference between them being in respect of the amount of crude fibre, which was somewhat less in the material from the State of Amazonas.

As previously indicated, certain differences in appearance were observable in the two samples of babassu fruits and between the corresponding kernels, but the kernels from both sources, and the oils and residual meals prepared

from them, were of very similar composition and gave figures closely resembling those previously recorded by Bray and Elliott. It therefore appears likely that the babassu kernels examined by these investigators were of the same botanical origin as the present samples.

Babassu kernels of the quality of the present samples would be readily saleable in the United Kingdom, if shipped in commercial quantities of at least 100 tons at a time, and should realise a price about equal to that of copra, which was recently quoted at £25 per ton in London.

### PATCHOULI LEAVES FROM SEYCHELLES

Two samples of dried patchouli leaves produced in Seychelles were forwarded to the Imperial Institute in December 1928, for examination. Each sample weighed 70 lb. One consisted of fermented leaves ("SPC London No. 1") and the other of unfermented leaves ("SPC London No. 2"). The leaves were reddish-brown to greenish-brown in colour and there was no appreciable difference in odour or appearance between the two samples.

Both samples, as received, contained 8.8 per cent. of moisture. They were distilled with steam at the Imperial Institute under the following conditions :

A copper still of 10 gallons capacity was employed, furnished with power-driven paddles to keep the material constantly agitated. The still was fitted with a live steam coil and a steam jacket. The amount of material found most convenient for each distillation was 7 lb. and the following procedure was adopted with each sample.

1. The leaves, cut into small pieces, were placed in the still with about  $5\frac{1}{2}$  gallons of water. The paddles were set in motion, and the contents of the still brought to boiling point by means of the steam jacket, steam at a pressure of about 10 lb. per sq. inch being employed for this purpose. After  $\frac{1}{2}$  gallon of distillate had collected the distillation was continued by means of the live steam

coil, from which steam entered at a pressure of about 7 lb. per sq. inch. From time to time, as the volume of liquor increased in the still, it was necessary to use the steam jacket. It should be noted that the above pressures are those of the steam on entering the jacket or still, and do not represent the actual pressure in the still itself, which would be but little above atmospheric.

It was found that in order to obtain practically the whole of the volatile oil present in the leaves at least 18 gallons of aqueous distillate had to be collected. After collecting the oil which had separated from the aqueous distillate, the further quantity of oil which remained in suspension and in solution was obtained by redistillation.

The results of these distillation trials with the two samples of leaves are given in Section No. I of the accompanying table together with the physical constants and solubility of the oils so obtained.

II. Further distillations of the leaves were carried out in order to ascertain whether there was any appreciable difference between the solubility and general qualities of the more volatile portion of the oil and that obtained towards the end of the distillation. In each of these experiments 7 lb. of cut leaves were steam-distilled as before; but the oil from the first 8 gallons of aqueous distillate was kept separate from that furnished by the last 10 gallons. The results obtained are given in Section II of the table.

III. Finally, a further charge of 7 lb. of the fermented leaves (Sample SPC No. 1) was steam-distilled, but only 13 gallons of distillate were collected and the oil obtained from the first 5 gallons was kept separate from that from the remaining 8 gallons. The results obtained in this experiment are given in Section III of the table.

From the above results it will be seen that the leaves furnished an excellent yield of oil. The constants of the oils from the fermented and unfermented leaves were very similar, and the solubility compares favourably with that of Singapore oils. As regards odour the oils from the unfermented leaves had a truer patchouli aroma than those from the fermented, while as regards persistency of

	I.		II.				III.	
	SPC No. 1 (Fermented).	SPC No. 2 (Unfermented).	SPC No. 1 (Fermented).		SPC No. 2 (Unfermented).		SPC No. 1 (Fermented).	
	Total oil.	Total oil.	1st Portion.	2nd Portion.	1st Portion.	2nd Portion.	1st Portion.	2nd Portion.
Gallons of aqueous dis- tillate collected from 7 lb. of leaves . . .	18	18	8	10	8	10	5	8
Yield of oil from leaves, per cent. . . . .	5.0	5.0	4.2	0.85	3.8	1.11	3.3	1.47
<i>Constants of Oil</i>								
Specific gravity at 15/15° C. . . . .	0.9692 — 56.22°	0.9688 — 57.18°	0.9714 — 57.87°	0.9635 — 50.37°	0.9731 — 60.50°	0.9600 — 50.16°	0.9723 — 58.00°	0.9660 — 55.19°
Optical rotation $\alpha_D$ Refractive index $n_{D^{20}}$ ° C. . . . .	1.509	1.509	1.510	1.509	1.510	1.509	1.510	1.509
Solubility in 90 per cent. alcohol at 15° C. . . . .	Soluble in 1 vol., becoming turbid on further dilution. Soluble in 8 vols.	Almost sol- uble in 8 vols.; sol- uble in 10 vols. No previous solution.	Soluble in 0.7 vols.; be- coming turbid with 1.2 vols. Soluble in 7 vols.	Soluble in 9 vols.; no previous solution.	Soluble in 0.6 vols.; be- coming turbid with 1.8 vols. Soluble in 6.5 vols.	Soluble in 9.5 vols.; no previous solution.	Soluble in 0.6 vols.; be- coming turbid with 1.4 vols. Soluble in 7 vols.	Soluble in 8.5 vols.; no previous solution.

odour there was very little difference. In the second series of distillations (No. II) the odour of the oils obtained in the second portions did not differ materially from that of the corresponding first portions, and the constants were also similar. The oils obtained throughout were of similar colour, being a fairly dark yellowish-green.

Four samples, representing respectively the 1st and 2nd portions of oil resulting from distillation No. II both of the fermented and the unfermented leaves, were submitted to two firms of essential oil distillers, who furnished the following observations regarding them.

(1) One of the firms regarded the 2nd portion from the unfermented leaves as more nearly approaching commercial patchouli oil than the other three samples submitted; the 1st portion from the unfermented leaves being next in value, followed by the 2nd portion and 1st portion, respectively, from the fermented leaves.

(2) The second firm considered that the oils from the unfermented leaves had a better odour than those from the fermented leaves, but that in each case the two portions were practically identical in this respect. They considered that, if the prejudice of buyers against oil from Seychelles could be overcome, oil of the quality of that obtained from the unfermented leaves should compete successfully with the patchouli oil from Singapore, which at present is realising 19s. 6d. to 20s. per lb. in London as against only 13s. 6d. to 14s. per lb. for the ordinary Seychelles patchouli oil at present imported.

The results of the present investigation show that the leaves furnish a good yield of oil, although the full quantity of 5 per cent. obtained in the present experiments would not be realised in practice on a commercial scale; that the oils obtained were similar in solubility to the commercial patchouli oils imported from Singapore, which are recorded as being soluble in from 3 to 10 volumes of 90 per cent. alcohol. The yield of oil and the solubility and general characters of the oil are satisfactory, and it would therefore appear that by the adoption of suitable methods it should be possible to distil patchouli oil in Seychelles which would be able to compete on the market with that shipped from Singapore.

## SISAL BOLES (STUMPS) AND POLES FROM KENYA COLONY AS SOURCES OF PAPER-PULP

The samples which are the subject of this report were forwarded to the Imperial Institute by the Kenya Sisal Growers' Association, in order that their value as sources of paper-pulp might be determined.

The material received consisted of boles and poles, in both the green and the dry state, as follows :

*Boles*

(a) *Green Bole*.—Weight 95 lb. A fresh green bole, with leaf-bases attached. The bole was  $3\frac{1}{2}$  ft. in length and  $1\frac{1}{4}$  ft. thick at its greatest diameter.

(b) *Dry Bole*.—Weight 18 lb. The dimensions of this bole, from which most of the leaf-bases had been removed, were: Length 3 ft., greatest diameter  $1\frac{1}{2}$  ft., average diameter about 9 in. After the remaining leaf-bases had been removed the bole consisted of a tough woody shell enclosing a mass of fibre and pithy matter. The leaf-bases were hard and fibrous.

*Poles*

(a) *Green Poles*.—Weight 37 lb. Six undried poles, 19 to 40 in. in length and varying from 2 to 4 in. in diameter. This sample had become infected with mould and was therefore not submitted to examination.

(b) *Dry Poles*.—Weight  $3\frac{1}{2}$  lb. Three pieces of pole, 4 to  $4\frac{1}{2}$  ft. in length and varying in diameter from  $1\frac{3}{4}$  to  $2\frac{1}{2}$  in. The pole had a woody outer layer about  $\frac{1}{8}$  in. in thickness; the interior consisted of light fibrous material embedded in pithy matter.

The examination of the materials was carried out on representative portions of each sample, except the green poles. In the case of the "green bole," the bole and leaf-bases were investigated together, in the proportions by weight in which they occurred in the sample, i.e. leaf-bases 82 per cent. and bole 18 per cent. expressed on the air-dried material. In the case of the "dry bole," separate investigations were made of the leaf-bases and the naked bole, and experiments were also carried out on a portion

of the latter which had been freed as far as possible from pithy matter by crushing and sieving.

The length and diameters of the ultimate fibres of the boles, leaf-bases and poles were found to be as follows :

Sample.	Length in mm.			Diameter in mm.		
	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.
Boles . . .	5.0	1.0	2.6	0.066	0.018	0.033
Leaf-bases . . .	2.0	0.7	1.2	0.064	0.020	0.033
Poles . . .	6.0	1.0	3.1	0.041	0.013	0.023

The ultimate fibres obtained from the boles and leaf-bases were quite unlike those of ordinary sisal leaf fibre, being very porous, and also short in proportion to their breadth and consequently possessing little felting power. The ultimate fibres from the dry poles on the other hand were similar in appearance and size to those of sisal leaf fibre.

The samples were chemically examined with the following results, which (except in the last column) are expressed on the air-dried material.

Sample.	Moisture.	Ash.	Cellulose.	Cellulose calculated on moisture-free material.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Green Bole (complete) . . .	8.7	6.3	49.7	54.4
Dry Bole (without leaf-bases) . . .	9.1	3.4	53.1 <sup>1</sup>	58.4 <sup>1</sup>
Dry Bole (without leaf-bases and partially freed from pithy matter) . . .	10.5	2.6	44.3	49.5
Dry Leaf-bases (from dry bole) . . .	11.1	6.7	49.5	55.7
Dry Poles . . .	9.3	3.6	52.4	57.7

<sup>1</sup> These figures include non-fibrous pithy matter, which in the pulping trials dissolved in the strong caustic soda solution used.

The various materials, after being suitably comminuted, were treated with caustic soda under conditions similar to those employed for the production of paper-pulp by the soda process on a commercial scale, with the following results. The figures are expressed on the air-dried material.

Sample.	Trial.	Caustic soda used.		Conditions of digestion.		Parts of caustic soda consumed per 100 parts of material.	Yield of dry pulp.	
		Parts per 100 parts of material.	Parts per 100 parts of solution.	Time.	Temp.		Un-bleached.	Bleached.
(1) <i>Green Bole</i> (air-dried)	A	20	3	hrs.	° C.		<i>Per cent.</i>	<i>Per cent.</i>
(2) <i>Dry Bole</i> (without leaf-bases)	A	20	3	5	160	14.1	46	37
	B	24	3	5	160	14.7	45	30
(3) <i>Dry Bole</i> (without leaf-bases and partially freed from pithy matter)	A	20	3	6	160	17.6	39	21
	B	24	3	5	160	14.25	47	32
(4) <i>Dry Leaf-bases</i>	A	20	3	6	160	17.9	40	26
	B	24	3	5	160	14.5	44	—
(5) <i>Dry Poles</i>	A	20	3	6	160	17.4	39	22
	B	20	3	5	150	11.2	58	45
	B	20	3	5	160	15.3	52	41

The characters of the pulps were as follows :

### (1) *Green Bole*

The pulp obtained was only partially disintegrated, mainly owing to the complex nature of the material. It furnished a coarse, dark brown, hard, rattly paper of unattractive appearance, showing excessive shrinkage, but of good strength. Treatment with a strong bleaching solution reduced the colour to dark cream, but the paper made from the bleached pulp still contained a large quantity of small unreduced fragments which had been little affected by the bleaching treatment. The bleached paper was of similar character and strength to the unbleached.

### (2) *Dry Bole (without leaf-bases)*

*Trial A.*—The pulp obtained under these conditions was of a very slimy nature, owing to the cellular matter present in the original material, and furnished a fairly hard, dark brown, opaque paper of close texture. The paper possessed no "wet" strength and was thus exceedingly difficult to manipulate, but the dry paper was of good strength. Treatment with a strong bleaching solution only reduced the colour of the pulp to a pale brownish-cream. The pulp then furnished a paper of similar character and strength to the unbleached paper. Numerous specks of partially disintegrated fibre were present in both papers.

*Trial B.*—The more drastic conditions of this digestion effected little improvement in the quality of the unbleached pulp. The pulp furnished a paper of similar character to that obtained in Trial A, but somewhat softer and of slightly greater strength. Treatment with a strong bleaching solution reduced the colour to a pale cream, and the bleached pulp furnished a fairly soft paper of fair strength. The fibrous specks had been reduced to a certain extent, but the bleaching treatment was not sufficient to remove them entirely.

(3) *Dry Bole (without leaf-bases and partially freed from pithy matter)*

*Trial A.*—The conditions of this digestion were just sufficient to produce a pulp of workable nature, which furnished a hard, brown, opaque paper of fair strength, but of rather unattractive appearance, and containing specks derived from the outer woody layer of the bole. Treatment with a strong bleaching solution reduced the colour to a dark cream, but numerous unbleached or partially bleached specks were present. The paper from the bleached pulp was of similar strength to that from the unbleached.

*Trial B.*—The more drastic conditions of this digestion, as in the case of the bole without leaf-bases, did not improve materially the quality of the resulting pulp. The pulp furnished an unattractive, coarse, brown paper, with numerous specks, but of fair strength. Treatment with a strong bleaching solution reduced the colour of the pulp to a pale cream, but the bleached pulp had extremely poor felting power and could not be made into satisfactory paper.

(4) *Leaf-bases*

*Trial A.*—The pulp produced consisted of slimy cellular matter, mixed with partially digested fibre. It furnished an unattractive, dark brown, coarse, ratty paper of fair strength, showing considerable shrinkage.

*Trial B.*—The more drastic conditions of this digestion served to produce a fairly well reduced pulp which was not quite so slimy in character as that obtained in Trial A.

The pulp furnished a dark brown paper, of similar strength and general character to that made from the pulp from Trial A and with the same shrinkage, but not so hard and slightly less coarse. Treatment with a strong bleaching solution reduced the colour to a pale cream. The paper furnished by the bleached pulp was of fair strength but rather hard and rattly, whilst numerous specks of unreduced material were present and could not be eliminated under the conditions employed.

### (5) *Dry Poles*

*Trial A.*—The conditions of this digestion were sufficient to yield a fairly well reduced pulp, which furnished a pale brown, opaque paper of good strength. Numerous specks of imperfectly reduced bark tissues were present. The pulp on treatment with a strong bleaching solution furnished a cream-coloured paper of similar strength and character to that from the unbleached pulp. The small fibrous specks, however, did not yield to the bleaching treatment.

*Trial B.*—The higher temperature employed in this digestion resulted in the production of pulp fairly free from unreduced matter. The pulp yielded a pale brown, opaque paper of fairly good quality and possessing good strength, but still containing specks. The pulp bleached fairly readily, and then furnished a very pale cream paper of similar strength and quality to the unbleached paper.

In connection with these trials it may be observed that only the pulp obtained from the poles possessed satisfactory "wet" strength. The pulps obtained from the boles and leaf-bases were exceedingly difficult to convert into paper.

### *Conclusions*

The foregoing results show that the boles, leaf-bases and poles all furnish good yields of unbleached pulp. The pulps from the boles and leaf-bases, however, were of unsatisfactory quality, being composed principally of short broad fibres which when wet possessed little strength or felting power. The paper produced in these cases showed considerable shrinkage; it was hard, coarse and

rattly, and contained numerous dark-coloured specks. There was moreover a very appreciable loss in the bleaching experiments, whilst neither the pulp from the boles nor that from the leaf-bases would bleach satisfactorily, and specks still persisted to a large extent in the papers. In addition, the materials contain pithy matter which adversely affects the quality of the pulp, causing shrinkage on drying. The removal of part of it in the case of the boles by mechanical means did not materially improve the quality, showing that the fibres of the materials do not possess satisfactory felting power.

On the other hand, the poles furnished an excellent yield of pulp, which, when prepared under the conditions of Trial B, bleached fairly readily. The paper was moreover very different in character from those produced from the boles and leaf-bases, being of much superior quality; it showed no appreciable shrinkage on drying, was fairly hard and strong, and the bleached paper, though not very opaque, was of fairly good quality and free from specks.

From the results of this investigation it would thus appear that the pole is the only portion of the sisal plant represented by the present samples which would be of interest for paper-making. Pulp prepared from the poles could be employed in the manufacture of brown wrapping paper or after bleaching (which is fairly readily accomplished) for the production of strong white paper of fairly good quality. The yield of pulp is also quite satisfactory.

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### SANIDINE SAND FROM KENYA AS A PUZZUOLANA

THE sample which is the subject of this investigation was sent to the Imperial Institute, at the request of the Director of the Geological Survey of Uganda, by the Director of Public Works, Nairobi, Kenya, in order that its value as a puzzuolanic material, when mixed with lime, might be ascertained by means of technical trials.

#### RESULTS OF EXAMINATION

The sample, which weighed about 56 lb., consisted of a coarse sand comprising fragments of orthoclase

felspar, pumice, quartz and volcanic glass. It is presumably the debris from a volcanic rock rich in porphyritic crystals of sanidine.

It had been suggested previously by the Director of the Geological Survey of Uganda that the finer portion of the sand might be more valuable as a puzzuolana than would be the coarser material.

In view of the above suggestion preliminary experiments were made to ascertain :

(1) If the finer portion of the sand when mixed with lime had puzzuolanic properties, either in the form obtained merely by sieving from the main bulk or after being finely ground.

(2) If the coarser portions of the sand would, after grinding, show superior puzzuolanic properties to the finer grade tested in (1) above.

Sieving tests carried out on the sample as received gave the following results :

	Per cent.
Retained on a 2-mesh sieve (aperture 0.375 in.) . . . . .	nil
Passing a 2-mesh and retained on a 4-mesh sieve (aperture 0.185 in.)	6.2
"    4        "        "        "    8        "    (    "    0.0934  ")	24.7
"    8        "        "        "   16        "    (    "    0.0462  ")	35.6
"   16        "        "        "   30        "    (    "    0.0228  ")	20.8
"   30        "        "        "   50        "    (    "    0.0115  ")	4.1
"   50        "        "        "  100        "    (    "    0.0058  ")	3.2
"  100 mesh        .        .        .        .        .        .	5.1

Comparative trials were also made with :

(a) A sample of commercial trass which was of such fineness that practically all passed through a 30-mesh sieve. It was air dried, then ground to leave a residue of 11 per cent. when sifted on a 180-mesh sieve (aperture 0.0038 in.).

(b) An artificial puzzuolana made from a Kenya shale which had previously been examined at the Imperial Institute from the point of view of its suitability for use in Portland cement manufacture. The shale was roughly powdered, roasted at a temperature of 700° C. for two hours, and then ground to leave a residue of 12.4 per cent. when sifted on a 180-mesh sieve.

The chemical analyses of (a) and of (b) (before roasting) are shown on p. 300.

TABLE I

		(a)	(b)
		Commercial trass.	Kenya shale.
		<i>Per cent.</i>	<i>Per cent.</i>
Silica . . . . .	SiO <sub>2</sub>	58.10	58.70
Alumina . . . . .	Al <sub>2</sub> O <sub>3</sub>	17.99	16.19
Ferric oxide . . . . .	Fe <sub>2</sub> O <sub>3</sub>	4.97	4.74
Titanium dioxide . . . . .	TiO <sub>2</sub>	—	1.07
Manganous oxide . . . . .	MnO	—	trace
Lime . . . . .	CaO	4.56	0.91
Magnesia . . . . .	MgO	2.17	1.65
Soda . . . . .	Na <sub>2</sub> O	—	2.38
Potash . . . . .	K <sub>2</sub> O	—	1.30
Sulphuric anhydride . . . . .	SO <sub>3</sub>	0.10	0.77
Phosphoric anhydride . . . . .	P <sub>2</sub> O <sub>5</sub>	—	0.04
Loss on ignition . . . . .		11.20	13.38

*Preliminary Experiments.*—The fraction of the sand passing the 100-mesh sieve consisted mainly of pumice and volcanic glass, little felspar being present, and constituted only about 5 per cent. of the sample as received. Mixtures were made of this fraction, both before and after grinding, with varying amounts of dry hydrated lime, but none of the test pieces moulded from these mixtures showed any marked hydraulicity.

The other fractions of the sanidine sand, and the samples of trass and burnt shale, were each ground to approximately the same fineness (i.e. about 90 per cent. passing a 180-mesh sieve) and then mixed with varying proportions of freshly slaked lime. After the addition of water the various pastes were moulded into circular pats which were stored at room temperature in an atmosphere saturated with moisture. The progress of hardening was tested periodically with a "Vicat needle." The hydrated lime used in these tests was prepared by slaking a "chalk lime" containing about 95 per cent. of caustic lime, the finely-divided powder produced being sifted through a 30-mesh sieve to remove small unslaked nodules.

The results of the preliminary experiments showed that the sanidine sand was much inferior to the trass or burnt shale in regard to its puzzuolanic properties. It was found that the finer gradings of the sanidine sand were generally inferior to the coarser, and that mixtures of 4 parts of each of the various grades to 1 part each of

lime gave the most satisfactory results. It was decided therefore to use the sand and lime in that proportion throughout the comparative tests for tensile strength and setting properties described below.

### *Quantitative Tests and Technical Trials*

In view of the results of the above-mentioned preliminary tests, and considering the labour and expense which would be involved in sifting and grinding the sanidine sand on a commercial scale, it was decided to separate it into three "fractions" only, viz.:

(1) Material passing a sieve having two meshes per linear inch and remaining on a sieve having 4 meshes per linear inch. This constituted 6 per cent. of the original material.

(2) Material passing the 4-mesh sieve and retained on one having 30 meshes per linear inch, and constituting over 80 per cent. of the original material.

(3) The fraction passing the 30-mesh sieve.

Partial chemical analyses of each fraction are given in the following table:

TABLE II.—SANIDINE SAND

#### *Composition of Fractions*

		Residue on a 4-mesh sieve.	Material pass- ing a 4-mesh sieve and re- tained on a 30-mesh sieve.	Material pass- ing a 30-mesh sieve.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Silica . . . .	SiO <sub>2</sub>	61.53	61.20	57.66
Alumina . . . .	Al <sub>2</sub> O <sub>3</sub>	16.27	16.81	15.09
Ferric oxide . . . .	Fe <sub>2</sub> O <sub>3</sub>	5.90	5.25	7.51
Titanium dioxide . . . .	TiO <sub>2</sub>	0.45	—	0.80
Manganous oxide . . . .	MnO	0.44	—	0.60
Lime . . . .	CaO	1.10	1.74	1.94
Magnesia . . . .	MgO	0.42	0.66	0.60
Sulphuric anhydride . . . .	SO <sub>3</sub>	0.14	0.13	0.15
Loss on ignition . . . .		0.90	1.46	4.61

*Setting and Hardening Properties.*—When mixed with lime in the proportions of 4 parts of the sanidine sand to 1 of lime and gauged into pats, the three fractions of the sanidine sand showed extremely slow setting and slow hardening properties. The "final" setting time of the pats made from the two coarser fractions (i.e. the period

which elapsed between gauging the pat and when the loaded 1-millimetre Vicat needle failed to make any appreciable mark on it) was approximately four times as long as the final setting time of the pats prepared from either the trass or the burnt shale.

*Tensile Strength of Pozzuolana-lime Mixture.*—Each of the three fractions of sanidine sand, together with the samples of trass and burnt shale, was ground to approximately the same fineness, and then mixed with one-fourth of its weight of dry hydrated lime, and was tested for tensile strength in accordance, as far as possible, with the specification for Natural Cements, 1927, of the American Society for Testing Materials.

The fraction of the sanidine sand passing a 30-mesh sieve was also tested (unground) with slaked lime.

In most cases the slow hardening properties of both "neat" and "sand" briquettes necessitated their being left in damp air for a period of sixteen days before they were sufficiently hard to place in water. The briquettes made from the portion passing the 30-mesh sieve were kept in damp air for 24 days before immersion in water, and for this reason the early period for testing was extended in this particular case to 8 weeks instead of the normal 28 days.

*Tensile Strength of Mixtures of Pozzuolanas with Lime and Standard Sand.*—It was considered desirable to ascertain the tensile strength of the sanidine sand and lime mixtures when used as mortars in admixture with standard cement-testing sand, but owing to the weakly hydraulic properties of the mixtures of sanidine sand and hydrated lime, only two parts of standard sand to one part of each mixture could be used in these tests.

The results of the above-mentioned tensile tests are shown in tables III, IIIA and IIIB.

It will be noted that the hydrated lime when tested alone showed appreciable strength when the test pieces were stored in damp air. The increased strength developed by the lime plus standard-sand briquettes at the later periods was very noticeable and was probably due to their more porous nature allowing carbonation of the lime by air to proceed more rapidly.

TABLE III.—SANIDINE SAND

Four parts of sanidine sand, separated by sifting as specified below, and mixed with one part of dry hydrated lime.  
*Tensile strength in pounds per square inch.*

Portion passing a 2-mesh sieve and retained on a 4-mesh sieve, ground to leave a residue of 10.4 per cent. on a 180-mesh sieve.		Portion passing a 4-mesh sieve and retained on a 30-mesh sieve, ground to leave a residue of 9.4 per cent. on a 180-mesh sieve.		Unground.		Ground.	
Water used for gauging—31.3%.		Water used for gauging—32.3%.		Water used for gauging—50%.		Water used for gauging—39%.	
At 28 days after gauging.		At 3 months after gauging.		At 8 weeks after gauging.		At 3 months after gauging.	
Air.	Water.	Air.	Water.	Air.	Water.	Air.	Water.
55	40	90	110	90	110	30	20
65	40	90	110	22	100	—	50
—	—	115	180	—	10	—	—
60	40	108	187	21	10	30	35



TABLE IIIA (continued).—BURNT SHALE  
Ground to leave a residue of 12.4 per cent. on a 180-mesh sieve.  
*Tensile strength in pounds per square inch.*

Four parts of above shale to one part of dry hydrated lime.			One part of 4 to 1 shale-lime mixture to two parts of British Standard Specification testing sand.		
Briquettes placed in water after two days in damp air.			Briquettes placed in water after three days in damp air.		
At 7 days after gauging.	At 28 days after gauging.	At 3 months after gauging.	At 7 days after gauging.	At 28 days after gauging.	At 3 months after gauging.
85	225	300	65	250	330
90	235	290	65	230	250
85	195	290	60	245	310
85	—	—	80	210	—
86	218	293	65	234	297

TABLE IIIB.—HYDRATED LIME  
*Tensile strength in pounds per square inch.*  
*Briquettes left entirely in damp air.*

Hydrated lime only.			One part of hydrated lime to two parts of British Standard Specification testing sand.		
At 28 days after gauging.	At 8 weeks after gauging.	At 3 months after gauging.	At 28 days after gauging.	At 8 weeks after gauging.	At 3 months after gauging.
40	30	30	20	30	40
30	30	30	20	30	40
30	20	30	20	30	35
30	30	25	40	40	35
32	28	29	25	33	38

The results of the tensile tests of the neat mixtures of hydrated lime with sanidine sand confirm those given by the preliminary tests, and the fraction of sanidine sand between the 4- and 30-mesh sieves proved the most satisfactory. The strength of the neat briquettes at 3 months in water, however, was only about two-thirds of that developed under similar conditions by the trass mixture, or by the burnt shale, whilst the corresponding sand briquettes had only about one-half the strength of the burnt shale-sand briquettes when tested at the same period after gauging.

The limited amount of shale available unfortunately prevented a set of briquettes being made for testing after storage in damp air.

*Practical Trials.*—Since the sanidine sand-lime mixtures showed some hardening properties comparable with those of a feebly hydraulic lime, it appeared probable that the sand-lime mixture could be used for such a purpose as a "rendering" on walls, provided the mixture was kept in damp air for some days after gauging.

Tests were therefore carried out by rendering a wall with two coats, each about  $\frac{1}{4}$  in. in thickness, of a mixture consisting of the 4 to 1 sanidine sand-lime mixture with twice its weight of quartz sand. The rendering was wetted at intervals during the first two days, and at the end of the third day it had hardened well on the exterior; the inside, although softer, was as hard as most fat-lime mortars would be after some weeks.

#### RECOMMENDATIONS AND SUMMARY

Although the sanidine sand-lime mixtures were inferior in strength to those of the more active puzzuolanic materials tested, they compared favourably with many types of hydraulic lime, and it is probable that the material, after separation by appropriate sieves and subsequent grinding, could be used in admixture with a "fat" slaked lime for building purposes as a substitute for a "feebly hydraulic" lime, or as an addition to such a lime with the view to increasing its strength.

If the best results are to be obtained from such mixtures

it is necessary that they should be kept in a damp condition for a few days after gauging.

It is questionable whether local requirements and conditions would justify the expense of sifting and grinding this material, or, alternatively, of burning and grinding the shale. In the absence, however, of a suitable argillaceous limestone which could be burnt direct to a hydraulic lime, the appropriate mixture of sanidine sand (or shale) with either a "fat" or slightly hydraulic lime should prove an efficient substitute.

That portion of the sanidine sand (5 per cent. only) which passes a fine (100) sieve, whether ground or not, showed but very slight hydraulicity when mixed with lime.

Economically, the portion of the sanidine sand best adapted for puzzuolanic purposes appears to be that passing a sieve having apertures of 0.185 in. (a 4-mesh sieve), and retained on one having apertures of 0.023 in. (a 30-mesh sieve), this "fraction" constituting about 80 per cent. of the sample.

It is necessary that the selected fraction should be finely ground before being mixed with lime to develop its puzzuolanic properties.

In the course of this investigation it has been found that the sample of Kenya shale, mentioned above, develops a highly satisfactory strength when suitably treated and mixed with lime, and the possibility of using such material for building purposes in Kenya might be worth attention.

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## ARTICLES

### NEW CROPS FOR THE COLONIES

#### ESSENTIAL OIL PLANTS

##### PEPPERMINT, GERANIUM AND LAVENDER

THE question of growing crops subsidiary to the staple products of the country is receiving considerable attention at the present time in a number of the tropical colonies and dependencies. The danger of relying too much on one crop is well known, and this has been brought home very

forcibly during the last year or two to tobacco planters in Rhodesia, Nyasaland and elsewhere, where production has increased much more rapidly than the demand for the newer types of leaf produced in these countries, with the result that large quantities have remained unsold.

In those countries, such as Northern Rhodesia, which are far removed from sea-ports, the difficulties of finding a subsidiary or alternative export crop are accentuated, since it is necessary that the produce should realise a sufficient price to cover the high cost of transport. During recent years the Imperial Institute has frequently been approached by planters in such countries for suggestions as to suitable crops that might be grown, and memoranda relating to those which appeared likely to meet the varying requirements of the enquirers have been furnished. Of the different products that have been suggested, certain essential oils, such as peppermint, geranium and lavender, are among the more promising, particularly for the higher regions of East Africa, and with a view to drawing attention to these products more widely than can be effected through the medium of individual enquirers, the following notes on the market conditions, the methods of cultivating the plants and of preparing the oils are published. The notes are only intended to give a brief outline of the subjects dealt with, and for further details the literature mentioned at the end may be referred to. It is desirable in all cases to consult the officers of the Department of Agriculture in the country concerned, who will be in a position from their knowledge of the local conditions to assist planters with advice regarding the cultivation of the crops.

In the case of each of the three plants mentioned, it is necessary to prepare the oil on the spot by steam distillation. This involves the erection of a suitable still, the cost of which, apart from the boiler, ranges from £120 upwards, according to size and make. It may be possible in certain instances for neighbouring planters to co-operate in the erection of a central still, to which their produce may be sent for treatment. The Imperial Institute will be pleased to advise planters as to the type of still required, and to supply the names of makers, and

also to furnish the names of merchants and brokers through whom essential oils may be disposed of.

### I. PEPPERMINT

*Areas of Production and Market Conditions.*—There is a large and constant demand for peppermint oil, which is used chiefly in confectionery and in the manufacture of flavouring essences and dentifrices.

The bulk of the peppermint oil of better quality is produced in the United States, the ordinary American oil being at present worth 15s. 6d. to 15s. 9d. per lb. (August 1929) in this country, whilst a special American grade is now realising 20s. 6d. to 21s. A small quantity of peppermint oil of a very superior grade is produced in England from cultivated plants (originally at Mitcham, though the plant is now grown in other districts); this oil commands a high price, the present quotations being about 105s. to 110s. per lb.

Peppermint oil is also distilled extensively in Japan. The Japanese oil has different characteristics from the American product, being obtained from a different plant. Japanese peppermint oil contains a higher percentage of menthol than any other peppermint oil, and part of the menthol is removed in Japan and is separately exported. The partly dementholised oil forms the Japanese peppermint oil of commerce. As a flavouring material the dementholised Japanese oil is markedly inferior to the American oil, but it has a very large sale on account of its low price, viz. about 6s. 4½d. to 6s. 6d. per lb. (August 1929).

Peppermint oil reaches this country packed in tins, that from America arriving in 20-lb. tins packed three in a case, whilst the Japanese oil is in 5-lb. tins, twelve in a case.

In addition to the above countries, peppermint oil has for some years past been produced in Italy, France and other European countries. The oil from these countries resembles the American oil in general characters.

*Production in the Empire.*—With the exception of the quantity produced in this country, and a small amount distilled in Western Australia, there appears to be no commercial production of peppermint oil at present in any British country. The Imperial Institute Advisory

Committee on Essential Oils has recently considered the question of the production of peppermint oil within the Empire, in view of the increasing demand for the oil in the world's markets and the fact that good prices are obtainable for oil of satisfactory quality. The Committee is of opinion that planters should be encouraged to experiment with the crop, and as a consequence the question has been brought to the notice of the Directors of Agriculture in various Colonies by the Imperial Institute. Arrangements are being made, with the assistance of the Royal Botanic Gardens, Kew, to send plants for trial cultivation to certain of the Departments who have expressed interest in the matter, and a request is being made for samples of the oil produced to be forwarded to the Imperial Institute for examination and valuation. It is hoped that by this means definite information will be forthcoming as to the most suitable countries for peppermint cultivation.

Most of the experiments hitherto carried out have been inconclusive, possibly owing, at least in part, to the variety grown having been unsuitable. Satisfactory results, however, appear to have been obtained in one instance in Kenya Colony, judging by the following extract from the *Perfumery and Essential Oil Record* for January 1915, although it should be mentioned that the Government Analyst's report on another sample of Mitcham peppermint oil grown in the Colony stated that the oil "was very disappointing, the aroma not being at all satisfactory."

"We have been favoured through Messrs. Lewis and Peat with a sample of peppermint oil distilled from Mitcham plants grown at Molo, in the highlands of British East Africa, about sixteen miles south of the Equator, latitude about  $35^{\circ} 40' E$ . We have not received particulars of the soil upon which it has been grown. The oil possesses a most excellent aroma, quite free from bitterness, and a very high figure indeed for menthol. The following is the complete analysis :

" Specific gravity . . . . .	0.967
" Optical rotation . . . . .	$33^{\circ} 30'$
" Total alcohols as menthol . . . . .	67.5 per cent.

" It is soluble in the proportion of 1 in 3 volumes of 70 per cent. alcohol, becoming cloudy with 10 volumes.

" There can be no question that this source of supply should be an important one in the future."

*Varieties.*—In North America and Europe the plants grown for the distillation of peppermint oil are varieties of *Mentha piperita*, whilst the Japanese oil is the product of *Mentha arvensis*.

Of *Mentha piperita* there are two varieties, one known as "black mint" (*Mentha piperita* var. *vulgaris*), and the other as "white mint" (*Mentha piperita* var. *officinalis*). Of these the "black mint" is the hardier and gives the larger yield of oil; "white mint," however, generally gives an oil of finer quality. The variety more commonly cultivated is the "black mint"; Mitcham peppermint is of this variety.

*Soil Conditions.*—According to the evidence available, peppermint grows well on a variety of soils, including light calcareous soils, and friable sandy loams, whilst gravels will also support the crop; in fact any soil (except heavy clay) seems to be suitable when well drained. It has been found, however, that both the quality and quantity of the oil is in some way influenced by the soil and situation. Chalky soils are said to yield a product giving an oil of high quality, whereas from peppermint grown on soils that promote rapid growth, although the yield may be greater it is believed that the quality of the oil is not so good.

*Cultivation.*—Peppermint is grown from rhizomes ("roots") and not from seed. The land is prepared during the previous autumn and winter by ploughing and manuring and brought to a fine tilth the following spring. In the United Kingdom planting takes place in May, pieces of "root" being dibbled in in rows 12 to 15 in. wide and from 12 to 18 in. apart. In America early in the spring the soil is harrowed and marked with furrows about 3 ft. apart. The "roots" used for planting are from one-eighth to one quarter of an inch thick, and 1 to 3 ft. long, and are placed in the furrow so as to form a continuous line.

As soon as the young shoots appear above ground, the

land is carefully hoed and cultivated at intervals, until the plants have sent out so many runners as to make further cultivation difficult. It is necessary that the land be kept free from weeds, as any strong smelling weed collected with the peppermint crop may seriously injure the quality of the oil obtained.

In the autumn, after harvesting, the beds are ploughed over to divide the runners and cover them with soil. This apparently harsh treatment is said to produce a better stand than when the plants are fully exposed to the weather. A dressing of dung is sometimes applied to the bed before the autumn ploughing.

Experiments have demonstrated the advantages of the use of artificial manures for peppermint, particularly potash, which is said to aid the plants to resist a rust disease that sometimes affects them. The following dressing for spring application has been recommended : 1 cwt. sulphate of ammonia, 2 cwts. superphosphate and  $1\frac{1}{2}$  cwts. sulphate of potash per acre.

A mint plantation lasts from four to five years, the best results being given in the second year, after which it deteriorates. After the fourth or fifth year the plantations are broken up, and the same land is not used again for mint growing for some years.

*Harvesting.*—The crop is ready for harvesting just before the flowers begin to open. The stills are then set to work and distilling goes on night and day until the crop is finished. Cutting is done with small sickles or scythes. As the mint is cut it is laid on the beds in long even rows to dry. After lying for a day or two in fair weather, it is gathered in small heaps and left again for two days, being turned once in the meantime. The mint is then made up into large bundles of about 1 cwt. enveloped in Russian mats, and carted away to the distillery. In this condition the mint is stated to keep indefinitely, and harvesting is then independent of the capacity of the still to deal with it. After distillation the spent mint is taken back to the fields and rotted down for manure.

*Distillation.*—Peppermint oil is obtained by subjecting the whole plant, as harvested, to steam distillation. This is commonly carried out in stills of very simple construc-

tion, consisting of a boiler connected to a condenser. A charge of the fresh plant is placed in the boiler, together with water; the boiler is heated and the water distils over, carrying with it the oil. Both water and oil are condensed together; the oil floats on the water and is easily separated from it.

It is best to use a boiler with a double bottom (i.e. with a perforated false bottom). If a false bottom is not present the material should not be placed in the boiler till the water is actively boiling.

More up-to-date plant, in which steam produced in a separate boiler is used instead of direct heating, is also sometimes employed. The installation for this method is somewhat more complicated, but it is to be recommended when operations are to be conducted on a large scale.

*Yield.*—The yield of oil varies between fairly wide limits. The weight of peppermint plant harvested generally averages about 3 to 4 tons per acre annually, and the oil obtained on distillation amounts to some 8 to 12 lb. per ton. The average yield of oil may be taken as about 30 to 40 lb. per acre per annum.

## II. GERANIUM

The name "geranium oil" has been applied in commerce to two classes of oil, viz. (1) the pelargonium oils, such as oil of rose geranium ("geranium rosat") and (2) certain andropogon oils, such as palmarosa oil (so-called Indian geranium oil), but it is now the usual practice to restrict the name to oils of the first group, and this type alone is dealt with in the present article.

*Areas of Production and Market Conditions.*—At present most of the supplies of geranium oil come from the French colonies of Réunion and Algeria. The oil is also produced at Grasse in the South of France, in Corsica, Madagascar and elsewhere. The geranium plant has been grown with success for some years in the highlands of Kenya Colony, and according to a communication sent to the Imperial Institute by the Director of Agriculture recently, of a total of 450 acres under essential oil-yielding plants in the Colony, 400 acres were planted with geranium.

It is understood that the area under the plant is now in excess of this figure.

Geranium oil is in good and constant demand for perfumery purposes, and French writers have recently strongly advocated the extension of its production.

In recent years the highest prices for geranium oil in the United Kingdom were realised in 1924; the range of prices of Bourbon (Réunion) and Algerian oil in that year and in 1928, and the price in August 1929, are shown below:

	Bourbon.	Algerian.
1924 . . .	28s. to 40s. per lb.	28s. 6d. to 40s. per lb.
1928 . . .	12s. 6d. to 20s. per lb.	11s. to 16s. 9d. per lb.
August, 1929 .	20s. 6d. to 21s.	21s. 6d.

The oil produced at Grasse is the finest in quality and in France commands a price about three and a half times that of the Réunion and Algerian oils.

Geranium oil is generally packed in drums of  $2\frac{1}{2}$  to 5 cwt., or in tins containing 28 to 35 lb.

*Varieties.*—Geranium oil is derived from several species of *Pelargonium*, the chief being *P. capitatum*, *P. Radula*, *P. graveolens* and *P. odoratissimum*. It is understood that the species grown at Grasse are *P. capitatum* (chiefly), *P. Radula* var. *roseum*, and *P. graveolens*. The plant grown in Réunion and Algeria is generally stated to be *P. capitatum*, but according to Parry (*Cyclopædia of Perfumery*) the odour of the Réunion oil more closely resembles that of *P. graveolens*.

*Climate and Soil Conditions.*—The geranium plant prefers a sheltered, warm situation, as it is injured by frost. Winter rains are detrimental to the plant, but a plentiful supply of water is necessary in the summer for the fullest development of the leaves, and in some countries irrigation is often resorted to in very dry seasons. It has been found, however, that although non-irrigated land gives a smaller yield, the oil produced is of finer quality. In Réunion, the plants are grown at altitudes of from 1,200 to 3,500 ft.

The plant succeeds best in a deep, rich, permeable soil, containing a plentiful supply of humus and sufficient lime to keep the soil sweet. Such a soil would be cool in summer and fairly dry in winter.

*Cultivation.*—The geranium is propagated by cuttings taken from strong, healthy plants producing the maximum amount of leaf. The cuttings should, as far as possible, be all of the same size and vigour, in order to produce a uniform stand in the plantation. The best plants are said to be obtained from cuttings possessing a heel of old wood, but as sufficient of these are not always available, simple shoots cut cleanly just below a node with a sharp knife may be used. In Algeria, the cuttings used are 10 or 12 in. long. All or most of the leaves, as well as the side shoots, are cut off with a knife, leaving four or five buds at the end of the branch, and the cuttings are then inserted, either directly in the field, or close together in rows 8 in. apart, in specially prepared nursery beds of light, sandy soil. In the latter conditions the cuttings root very quickly, and as soon as the rootlets show, the cuttings are set out in the plantation, about 6 or 8 in. of the shoot being below the surface. The cuttings are put out in the late autumn.

The soil of the plantation should be thoroughly prepared and manured, as in the warmer countries the land will be occupied by the crop for several years. The addition of superphosphate of lime at the rate of about 1,000 lb. per acre per annum has been found to increase greatly the yield of oil.

The distance of planting varies in different countries. In the South of France the best results are stated to be obtained by planting the rooted cuttings at a distance of about 3 ft. each way, or 10,000 to the acre. In Algeria they are sometimes planted at distances of 12 to 15 in. in rows about 30 in. apart. In Réunion, also, the planting distance is less than in the South of France, and in this case it has been recommended that a greater distance should be allowed between the plants in order to prevent the attack of a rust disease which is prevalent in the island owing to persistent rains.

The plantation should be systematically hoed, weeded and irrigated where necessary in the summer, and manure dug or raked in in the autumn, after harvesting.

*Harvesting.*—The crop, consisting of the leafy twigs, is harvested by means of sickles or sécateurs just before

the plant flowers, when the leaves begin to turn yellow and their scent becomes more like that of roses and less like that of lemon. The cutting should be done in sunny, cloudless weather, in order to keep the material as dry as possible.

The number of crops that can be obtained each year depends on the climate. In France where, owing to frosts, the plant is grown as an annual, usually only one crop is gathered, in August or September, but if the season is specially favourable another is sometimes obtained in October or November. In Algeria the plants continue to grow for from four to eight years, and after the first year it is possible to harvest three crops annually on irrigated land, the first about April, a second in June or July, and another in October or November, although the last is often omitted if three crops were obtained the previous year, making five crops in two years. In Réunion cutting takes place all through the year.

*Distillation.*—The essential oil of geranium is probably chiefly contained in the leaves, though the usual practice is to distil the green branches with the leaves and flowers that are on them, only the woody portions being rejected. The material should be distilled as soon as possible after harvesting. If stored it is liable to ferment and deteriorate.

In Algeria and Réunion distillation is commonly effected by means of primitive types of stills, but the use of modern steam stills is strongly advocated. Each charge is distilled for about an hour and a half.

*Yield.*—The quantity of oil annually obtained per acre depends on the number of crops it is possible to harvest each year, and on the oil content of the shoots, which varies somewhat in the different countries. In Algeria the annual yield of oil per hectare is stated to be 25 to 30 kilos. The yield of oil from the fresh material ranges from 0.1 to 0.2 per cent. Where three cuttings are obtainable, the second crop is usually the smallest, but contains a higher percentage of oil than the others. In this connection the following figures have been recorded in Algeria: 1st cutting: 16,000 kilos. of fresh material gave 20 kilos. of oil (0.125 per cent.); 2nd cutting: 2,600

to 3,200 kilos. gave 5 to 6 kilos. of oil (0.192 and 0.1875 per cent. respectively) ; 3rd cutting : 6,000 to 8,000 kilos. gave 4 to 5 kilos. of oil (0.0625 and 0.066 per cent.).

### III. LAVENDER

*Areas of Production and Market Conditions.*—Lavender oil is used principally in perfumery and in the manufacture of toilet soaps and other toilet requisites. It is one of the most largely used essential oils ; the demand for it is regular, and there seems to be no reason to doubt that it will be well maintained.

Two main varieties of lavender oil are recognised on the market, viz. true lavender oil and spike lavender oil, which are derived from different species (see below).

The principal countries producing lavender oil are France and Spain, the true lavender oil being distilled chiefly in the former, and the spike lavender oil mainly in the latter country. Spike lavender oil is used very extensively in soaps and the cheaper class of perfumery, in cases where true lavender oil would be too expensive. The present prices of these oils in London are approximately as follows :

True lavender oil (French) : 15s. to 15s. 6d. per lb. (August 1929).

Spike lavender oil (Spanish) : 3s. 6d. to 4s. 6d. per lb. (August 1929).

A small quantity of true lavender oil is also produced in England. This oil is of the highest quality and its present price is about 150s. per lb.

Lavender oil is imported from France in drums of 1 to 3 cwts., smaller quantities being in tins of 20 to 28 lb., three or four of which are contained in a case.

*Varieties.*—The best oil is distilled from the plant commonly called " English " lavender (*Lavandula vera* or *Lavandula officinalis*). The aspic or spike lavender (*Lavandula spica* or *Lavandula latifolia*), which occurs in Southern Europe, yields an oil of much lower commercial value. English lavender oil is obtained from cultivated forms of *L. vera*, whilst French lavender oil, which is produced in very much larger quantities, is distilled mainly

from wild plants of the same species, that are found to vary considerably in character in different localities.

*Climatic and Soil Conditions.*—For successful growth and the fullest development of essential oil, lavender requires a moderately warm, dry climate. It is liable to injury by frost and suffers in the winter if the ground is too moist. A well-drained light loamy soil suits it best, especially one overlying chalk. In the absence of a chalky subsoil the soil is improved by a top-dressing of lime or other calcareous material. A rich soil should be avoided, as this tends to over-luxuriant vegetative growth, at the expense of the flowers from which the oil is obtained.

*Cultivation.*—The numerous forms of lavender cross very readily, and in order to obtain a uniform field it is necessary to propagate the plant by means of cuttings. These consist of young shoots, taken in early spring, and inserted about 2 in. apart in prepared beds. Any flowers which may appear on the rooted cuttings are removed in order to induce as much growth as possible by the late autumn, when the plants are set out in the plantation.

After being trimmed the plants are dibbled in at a distance of 18 in. in rows 18 in. apart, the ground having previously been well dug and prepared. They must be deeply and firmly planted, leaving the top 2 in. only above ground. After a year in the fields alternate plants and rows are removed, so as to give a spacing distance of 3 ft. each way. The plants removed can be split up and used for planting up fresh land.

In England, the plants are seldom retained after the fifth year and, in order to maintain a continuous supply of flowers for distilling, the land under lavender can be divided into six areas, five of them bearing plants of successive ages, whilst the sixth is allowed to remain fallow for a year.

The effect of continuously cutting the lavender is to induce a very bushy habit, which tends to prevent the free circulation of the air round the plant and encourages the growth of fungoid disease. It is advisable, therefore, to thin out the plants as required during the dormant season.

*Harvesting.*—For distillation, only the flowers are used, the stalks being cut with a sickle. They are ready for harvesting for this purpose when the top flowers of the spike are fully out, by which time the lower ones will have faded. If required for sale as dried lavender, however, the spikes must be cut earlier, when the middle flowers of the spike are expanded and the top ones still in bud.

For distilling, the spikes are cut when the sun is shining, so as to ensure their being in a thoroughly dry state, and are immediately covered with Russian mats to prevent scorching. Distillation should take place as soon as possible after harvesting, but if the spikes have to be stored they should be spread out in thin layers in a cool shed to prevent fermentation.

*Distillation.*—The whole spike, with about 6 in. of stalk, is distilled. For this purpose a modern type of still should be employed, and to secure the best type of oil distillation should proceed only for about  $3\frac{1}{2}$  hours. The water employed should preferably be soft, as carbonate of lime decomposes the characteristic constituent of lavender oil. To prevent the accumulation of carbonate of lime in the still, the latter should be emptied after each charge.

*Yield.*—The yield of oil obtained varies according to the conditions, but on an average it may be taken that an acre of lavender in its prime would in a favourable year furnish from 2,680 lb. to 3,580 lb. of fresh flowers, whilst the yield of oil would be from 0.5 to 0.8 per cent., that is, a mean yield of, say, 20 lb. of oil per acre.

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## CITRUS PRODUCTS

THE following article is based on a memorandum recently supplied to the Empire Marketing Board by the Imperial Institute.

The most important citrus products from a commercial standpoint are the following :

1. *Citrate of Lime* and its derivative *Citric Acid*.
2. *Concentrated Juice*.
3. *Raw Juice*.
4. *Essential Oils*.

The principal fruit concerned is the lemon, but the lime is also a valuable source of the products, while increasing quantities of oranges are also being utilised, especially in the United States. It may be mentioned that pineapple juice and pineapple waste, which are obtained in large quantities from the canning factories, are now used in the United States as an important source of citrate and citric acid.

### 1. CITRATE OF LIME AND CITRIC ACID

Although citric acid is present, together with small amounts of other organic acids, in the juice of citrus fruits, it is not feasible to extract the acid direct from the juice. The citric acid is always first separated by means of its sparingly soluble calcium salt. For this purpose the hot juice, after suitable preliminary treatment, is neutralised by the addition of whiting or ground chalk, or ground limestone if sufficiently pure; the citrate of lime which

is precipitated, is filtered off, washed and dried. The citrate may be prepared either from freshly extracted juice or from the concentrated juice. Details of the method of preparing calcium citrate are given in the Appendix to this article.

Citric acid is prepared from the citrate of lime by treatment with sulphuric acid and is purified by recrystallisation.

A very pure grade of citric acid can be obtained by the fermentation of sugar with certain moulds, and within the last few years this process has been established on a commercial scale both in Europe and America.

The imports of citrate of lime and of citric acid into the United Kingdom, with the countries of origin, are shown in Table I.

It will be seen from the figures that Italy is by far the most important source of both products. The industry in that country is highly organised, and it should be noted that the lemons used for the preparation of the essential oil and citrate of lime are the surplus fruit remaining over after the needs of the important export trade in fresh lemons have been satisfied. Unusually favourable conditions in the fruit industry may therefore result in restriction of the supplies of lemons available for the citrate and citric acid industries. On the other hand if there is a reduced demand for fresh fruit the surplus is used for the production of oil and citrate, the latter of which is at once consigned to an organisation at Messina (the Camera Agrumaria) at a price fixed in advance. The average production of citrate in Sicily is stated to be 7,000 to 8,000 tons per annum, and some time ago large stocks had accumulated at Messina. These, however, have been substantially reduced during recent years and last year amounted to about 10,000 tons.

As the great bulk of the world's supply of citrate has been produced in Sicily, the Camera Agrumaria has been able to control the market and to fix the selling price. Latterly as a result of this control the manufacture of citric acid in Italy has been largely developed and less citrate has been available for manufacturers in other countries. By arrangement with the Italian producers

the manufacture of citric acid in Germany was abandoned several years ago and Germany now imports the acid instead of the citrate from Italy. Table IA gives the exports of citrate of lime and of citric acid from Italy during recent years.

A recent development in the Italian industry is the formation of "Cifac" (Consorzio Italiano Fabbriche Acido Citrico), a syndicate of all the Italian citric acid manufacturers with offices in Messina, the object of which is to control the supply, distribution and price of the citric acid made by the firms concerned. It is understood that the firms comprising the syndicate will have first call on the citrate made in Sicily and that only such quantities will be exported as the firms cannot immediately handle. The effect of this arrangement will be felt most in countries, such as the United Kingdom, which are wholly or mainly dependent on imported supplies of citrate and citric acid. It should stimulate, however, the production of citrate in other countries and may also have an influence on the development of the manufacture of citric acid from sugar by fermentation processes.

The United States (California) is a producer of citrate of lime, the surplus lemon and orange crop being employed in its manufacture as well as pineapple juice and waste. Concentrated lime juice is also imported from the West Indies, and citrate of lime from Italy for the manufacture of citric acid. The fermentation process is now being employed on a commercial scale in the Eastern States.

The production of citrate of lime in the British West Indies has practically ceased and the exports now consist of raw or concentrated lime juice.

Citrate of lime was formerly made in British Guiana from lime juice, but the manufacture failed to give remunerative results and ceased in 1921.

The production of citrate of lime was undertaken in East Africa in 1921, but was soon discontinued and no developments have since taken place. Judging, however, from enquiries received recently at the Imperial Institute from both Kenya and Tanganyika, interest is again being taken in the product in those countries.

Small quantities of citrate of lime have been produced

recently in Cyprus from locally grown lemons and consignments which reached this country were of satisfactory quality.

To sum up, it may be stated that there is a good demand for citrate of lime in this country at the present time owing to the limitation of exports from Italy. British manufacturers of citric acid have stated that they would welcome additional supplies from Empire sources and these, if of good quality, would meet with a ready sale.

As regards the future demand, the possibility of an increased production of citric acid by fermentation methods has to be taken into account, but at present it is not possible to estimate the extent to which this new process will be utilised commercially.

The standard strength of commercial citrate of lime is 64 per cent. of citric acid. The price in London has recently been about £22 per "pipe" of 6 cwt. (on basis of 64 per cent. citric acid content).

## 2. CONCENTRATED JUICE

The chief citrus fruits used in the preparation of concentrated juice are lemons (in Italy) and limes (in the West Indies). The raw juice as expressed from the fruits is usually concentrated by evaporation either in open pans or preferably in steam-heated stills.

In making concentrated lime juice in a steam-heated still, the oil which distils over is collected and marketed as "distilled oil of lime." The value of this oil is an important item in the financial returns obtained from the process.

Concentrated juice forms a convenient medium for the transport of citric acid in those cases where, owing to the absence of suitable whiting or chalk, or through other causes, it is impracticable to make citrate of lime. The juice is used not only as a source of citrate of lime and ultimately of citric acid, but is also employed directly for certain industrial purposes.

The trade returns of the United Kingdom do not differentiate between concentrated and raw juice, or

between lemon and lime juice. The total imports of such juices into this country have been as follows :

—	1924.	1925.	1926	1927.
	<i>gallons.</i>	<i>gallons.</i>	<i>gallons.</i>	<i>gallons.</i>
<i>Total . . . . .</i>	424,810	497,982	540,625	467,109
From British West Indies .	281,527	368,608	264,260	184,092
Italy . . . . .	88,586	101,600	256,534	266,930

Speaking generally, it may be said that juice from the British West Indies consists of both concentrated and raw lime juice, while that from Italy is mainly raw lemon juice. Some idea of the quantity of concentrated lime juice imported into this country may be obtained from the figures given in Table II which show the exports from the chief producing countries.

The exports of concentrated lime juice from the British West Indies have fallen much below the figures of former years, owing to the damage caused by root diseases and withertip disease in Dominica which has resulted in a greatly reduced yield of fruit in that island.

Other British countries which are producing concentrated juice on a small scale are the Union of South Africa and Cyprus. In both cases lemons are used as a source of juice.

Concentrated lime juice was prepared in East Africa in 1921, but the manufacture was not continued on a commercial scale.

In view of the established market in this country for concentrated lime juice, its production could be safely undertaken as an alternative to the preparation of citrate of lime. It is important, as indicated above, that the essential oil expressed with the juice should be recovered during the process of evaporation as its value adds considerably to the financial return obtained.

The juice is concentrated until it contains about 100 oz. of citric acid per gallon and is exported in casks containing 40 to 50 gallons. The present price in London is £28 per pipe of 108 gallons containing 64 oz. of citric acid per gallon. The price of concentrated juice containing larger amounts of citric acid per gallon is proportionally higher.

### 3. RAW JUICE

Raw citrus juice, prepared from limes, lemons and oranges, is used for making beverages. As explained in the preceding section on concentrated juice, it is not possible to give the imports of raw citrus juices into the United Kingdom. The exports from the chief producing countries, so far as figures are available, are shown in Table III.

The production of raw lime juice in the West Indies, as in the case of the concentrated juice, has been greatly affected by diseases.

The demand for raw lime juice is seasonal and largely influenced by the character of the summer weather. The state of the market is an important factor in deciding whether raw juice can be profitably shipped, and it is therefore necessary for producers to keep in close touch with importers in this country. The present price of raw lime juice in London is about 4s. 6d. per gallon.

During the last three or four years there has been a very large increase in the export from Italy of raw lemon juice, which is being increasingly utilised for the production of beverages.

### 4. ESSENTIAL OILS

The chief essential oils produced from citrus fruits are the following: Lemon oil, Lime oil, Orange oil, Bergamot oil and Mandarin oil. The oils are obtained from the peel by pressure and in the case of limes and oranges also by distillation.

In making the expressed oils, the oil cells in the peel are ruptured by pressure or by rotating the whole fruit in an *écuelle*, and the oil which exudes is collected. The finest lemon oil is obtained in Sicily by pressing the peel in contact with a sponge, which absorbs the oil. Recently, pressing machines have been introduced in Sicily for the purpose. Expressed lime oil is chiefly made in the West Indies by the process of *écuellage*.<sup>1</sup> In the case of limes

<sup>1</sup> An *écuelle* is a saucer-shaped vessel made of tinned copper, the inside of which is covered by short spikes, about  $\frac{1}{2}$  in. long. The fruit is placed in the *écuelle* and by a rapid rotatory motion the oil cells are ruptured and the oil so released is collected through a tube leading from the bottom of the *écuelle*.

and oranges the fruit after being écuelled is submitted to pressure whereby the juice is expelled together with a further quantity of oil.

Distilled lime and orange oils are obtained as by-products in the manufacture of the concentrated juice, as mentioned in section 2 (p. 325). Citrus oils prepared by distillation are of lower quality and value than expressed oils, owing to changes brought about during the process of distillation.

It is not possible to state the imports of the various citrus oils into the United Kingdom, but the exports from certain producing countries are shown in Table IV. Other important exporting countries are Spain and France. Hitherto these countries have not published figures showing the export of citrus oils, except that in 1928 the total export of all citrus oils from France is given as the equivalent of 74,005 lb.

The principal source of supply of lemon oil is Italy, although increasing quantities are now being produced in California. The latter oil is chiefly marketed in the United States. There is always a good demand for lemon oil and during 1928 the price in London rose steadily from 8s. per lb. in January to 12s. 6d. in July and to 14s.-15s. at the end of the year. The present price is 15s. 6d.-16s. per lb. in London.

The rise in price is attributed in the market to a reduction in the Italian production. The Imperial Institute has recently been informed that owing to the large demand for fresh lemons last season much of the fruit which would have been used in Italy for the manufacture of oil and citrate was exported and that consequently the amount of oil produced was very low.

Lime oil has been realising high prices owing to a good demand and shortage of supplies from the West Indies due to diseases and the effect of the recent hurricane. Up to 34s. per lb. has been paid recently in London for the distilled oil, and the range in price during 1928 was 24s. to 30s. per lb. The London price of the hand-pressed oil ranged from 35s. to 40s. per lb. during 1928; this oil is at present scarce and worth nominally 65s. per lb.

## CITRUS PRODUCTS

329

TABLE I. TOTAL IMPORTS OF CITRATE OF LIME AND CITRIC ACID INTO THE UNITED KINGDOM

Particulars.	1924.	1925.	1926.	1927.	1928.
	lb.	lb.	lb.	lb.	lb.
CITRATE OF LIME					
Total . . .	3,599,680	4,326,560	5,587,344	4,812,528	(a)
From :					
Italy . . .	3,553,984	4,311,776	5,464,368	4,496,016	(a)
Spain . . .	—	11,424	119,392	309,792	(a)
Other Foreign Countries . . .	896	—	—	—	(a)
British West Indies . . .	40,320	3,360	3,584	—	(a)
Other British Empire . . .	4,480	—	—	6,720	(a)
CITRIC ACID					
Total . . .	542,080	782,544	624,512	674,576	(a)
From :					
Italy . . .	506,464	738,752	554,960	602,000	(a)
Netherlands . . .	24,976	7,840	18,816	17,584	(a)
France . . .	10,640	16,240	22,512	38,080	(a)
Other Foreign Countries . . .	—	18,592	28,224	16,912	(a)
British Empire . . .	—	1,120	—	—	(a)
<i>Re-exports from the United Kingdom</i>					
CITRATE OF LIME . . .	—	—	—	—	(a)
CITRIC ACID . . .	57,568	89,600	68,800	21,504	(a)

(a) Information not yet available.

TABLE IA. EXPORTS OF CITRATE OF LIME AND CITRIC ACID FROM ITALY

*Citrate of Lime*

—	1924.	1925.	1926.	1927.	1928.
	lb.	lb.	lb.	lb.	lb.
Total . . .	8,322,890	10,313,223	10,132,665	6,846,455	3,587,141
To :					
United Kingdom	3,474,705	4,418,063	4,646,021	4,637,643	2,308,901
France . . .	2,009,072	2,265,470	2,631,217	2,208,812	1,254,430
Germany . . .	378,313	—	441	—	(a)
United States . . .	2,458,374	3,628,367	2,632,099	—	—

*Citric Acid*

Total . . .	4,256,244	6,119,811	4,544,388	4,412,552	7,358,147
To :					
United Kingdom	528,007	704,156	595,028	578,272	1,209,676
France . . .	285,278	601,201	580,477	562,179	1,147,285
Argentina . . .	511,693	582,902	619,278	491,851	759,492
United States . . .	805,789	754,201	190,920	103,397	63,273
Germany . . .	541,455	1,140,231	179,236	688,283	1,330,710

(a) Information not yet available.

TABLE II. EXPORTS OF CONCENTRATED CITRUS JUICE

—	1924.	1925.	1926.	1927.	1928.
	<i>gallons.</i>	<i>gallons.</i>	<i>gallons.</i>	<i>gallons.</i>	<i>gallons.</i>
LEEWARD ISLANDS (Lime Juice)					
<i>Dominica</i> : Total .	237,369	111,778	104,014	106,971	90,731
To:					
United Kingdom	19,514	1,512	88	6,521	(a)
United States .	217,855	110,266	102,364	100,030	(a)
<i>Antigua</i> : Total .	—	290	2,050	5,250	2,350
To:					
United Kingdom	—	290	2,050	—	(a)
United States .	—	—	—	5,250	(a)
WINDWARD ISLANDS (Lime Juice)					
<i>St. Lucia</i> : Total .	33,718	40,858	35,234	38,064	18,028
To:					
United Kingdom	2,240	—	120	—	9,448
Canada .	220	—	—	—	—
United States .	31,258	40,858	35,114	38,064	8,580
<i>Grenada</i> : Total .	7,331	9,075	6,520	11,048	18,720
To:					
United Kingdom	1,831	3,450	2,520	5,350	18,040
United States .	5,500	5,625	4,000	5,698	680
TRINIDAD AND TOBAGO (Lime Juice)					
Total . . . . .	7,505	6,171	7,886	4,488	(a)
To:					
United Kingdom	5,562	1,680	1,128	—	(a)
United States	1,743	4,491	6,758	4,488	(a)
British North America .	200	—	—	—	(a)
JAMAICA (Lime Juice)					
Total . . . . .	54,206 <sup>1</sup>	87,755 <sup>1</sup>	21,399 <sup>1</sup>	5,027	43,791 <sup>1</sup>
To:					
United Kingdom	34,834	85,365	17,096	—	(a)
United States .	10,408	975	518	4,820	(a)
BRITISH GUIANA (Lime Juice)					
Total . . . . .	9,650	8,430	4,974	5,249	1,124
To:					
United Kingdom	—	—	160	93	8,124
United States	9,650	8,430	4,814	5,156	—
MARTINIQUE (Lime Juice)	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>
Total: . . . . .	36,597	81,571	—	(a)	(a)
ITALY <sup>2</sup>					
Total . . . . .	1,500,466	2,248,053	2,270,541	1,287,058	841,945
To:					
United Kingdom	87,083	54,234	125,663	(a)	(a)
Czechoslovakia	6,834	—	—	(a)	(a)
United States .	1,373,921	2,174,639	2,142,232	(a)	(a)

(a) Information not yet available.

<sup>1</sup> Including raw juice; separate figures for 1923-26 and 1928 not available.<sup>2</sup> The juice exported from Italy is described in the Trade Returns as "lemon and lime juice"; most, if not all, consists of lemon juice.

## CITRUS PRODUCTS

331

TABLE III. EXPORTS OF RAW CITRUS JUICE

—	1924.	1925.	1926.	1927.	1928.
	<i>gallons.</i>	<i>gallons.</i>	<i>gallons.</i>	<i>gallons.</i>	<i>gallons.</i>
LEEWARD ISLANDS (Lime Juice)					
<i>Dominica</i> : Total	348,324	313,247	268,760	173,848	306,090
To :					
United King- dom . . .	233,902	227,210	198,077	105,255	(a)
British N. America .	32,488	29,891	11,386	20,886	(a)
United States	71,097	51,786	55,587	44,601	(a)
<i>Montserrat</i> : Total	22,551	6,497	31,184	33,697	2,422
To :					
United King- dom . . .	8,579	6,497	31,184	21,551	(a)
British N. America .	13,532	—	—	11,619	(a)
<i>Antigua</i> : Total .	1,650	—	2,950	—	840
To :					
United States	1,200	—	—	—	(a)
WINDWARD ISLANDS (Lime Juice)					
<i>St. Lucia</i> : Total	8,490	23,428	43,893	17,509	12,598
To :					
United King- dom . . .	700	23,028	42,921	10,950	10,762
Canada . . .	1,200	400	971	6,559	1,796
Barbados . .	—	—	1	—	—
Bermuda . . .	6,340	—	—	—	—
St. Vincent .	—	—	—	—	40
United States	250	—	—	—	—
<i>St. Vincent</i> : Total	175	438	10	(b)	(b)
To :					
Barbados . .	175	438	10	—	—
JAMAICA (Lime Juice)					
Total . . . . .	54,206 <sup>1</sup>	87,755 <sup>1</sup>	21,399 <sup>1</sup>	27,554	43,791 <sup>1</sup>
To :					
United King- dom . . .	34,834	85,365	17,096	22,175	(a)
United States .	10,408	975	518	3,103	(a)
BRITISH GUIANA (Lime Juice)					
Total . . . . .	135	(b)	(b)	(b)	(b)
To :					
United King- dom . . .	135	(b)	(b)	(b)	(b)

(a) Information not yet available.

(b) Not shown in Trade Returns.

<sup>1</sup> Including concentrated juice ; separate figures for 1923-26 and 1928 not available.

TABLE III. EXPORTS OF RAW CITRUS JUICE—*continued*

—	1924.	1925.	1926.	1927.	1928.
	gallons.	gallons.	gallons.	casks.	casks.
NORFOLK ISLAND <sup>1</sup> (Lemon Juice)					
Total . . .	(a)	(a)	(a)	226	170
To:					
Australia .	(a)	(a)	(a)	220	(a)
New Zealand	(a)	(a)	(a)	6.	(a)
ITALY <sup>2</sup>	lb.	lb.	lb.	lb.	lb.
Total . . .	1,140,672	1,718,283	4,239,048	5,466,581	5,983,345
To:					
United Kingdom	784,405	1,025,811	2,262,605	(a)	(a)
France . . .	99,428	33,951	9,259	(a)	(a)
Germany . .	192,464	457,018	1,726,000	(a)	(a)
United States .	9,259	142,860	109,129	(a)	(a)

(a) Information not yet available.

<sup>1</sup> Years ended June 30th.<sup>2</sup> The juice exported from Italy is described in the Trade Returns as "lemon and lime juice"; most, if not all, consists of lemon juice.

TABLE IV. EXPORTS OF CITRUS OILS

## 1. Exports of Lemon Oil

—	1924.	1925.	1926.	1927.	1928.
	lb.	lb.	lb.	lb.	lb.
ITALY					
Total . . .	1,653,579	1,712,299	1,371,405	1,259,756	1,384,507
To:					
United Kingdom	538,245	483,776	383,388	} Figures not yet available	
Australia .	82,742	39,564	42,135		
France . . .	182,278	222,330	189,492		
Germany . .	184,346	174,154	122,390		
Netherlands .	51,365	30,801	30,655		
United States .	474,457	589,161	484,607		

## 2. Exports of Lime Oil

LEEWARD ISLANDS					
Dominica:					
Écuellé:					
Total . . .	11,795	10,306	9,381	7,828	1
To:					
United Kingdom	1,877	2,134	608	3,532	(a)
United States .	9,918	6,457	8,479	3,673	(a)
Distilled:					
Total . . .	37,244	35,373	33,471	31,346	1
To:					
United Kingdom	14,458	22,531	11,750	17,423	(a)
United States .	21,316	8,817	18,291	13,923	(a)

(a) Information not yet available.

<sup>1</sup> The preliminary trade returns for 1928 show a total export of 32,174 lb. of lime oil, including both écuellé and distilled oils.

## CITRUS PRODUCTS

333

TABLE IV. EXPORTS OF CITRUS OILS—*continued*2. Exports of Lime Oil—*continued*

—	1924.	1925.	1926.	1927.	1928.
	lb.	lb.	lb.	lb.	lb.
LEEWARD ISLANDS— <i>continued</i>					
<i>Antigua</i> :					
Total <sup>1</sup> . . .	—	—	—	1,246	934
To :					
United States	—	—	—	1,246	(a)
<i>Montserrat</i> :					
Écuclled :					
Total . . .	—	152	34	41	(a)
Distilled :					
Total <sup>1</sup> . . .	484	—	—	—	(a)
WINDWARD ISLANDS					
<i>St. Lucia</i> :					
Hand-pressed :					
Total <sup>2</sup> . . .	2,710	4,400	5,078	3,335	4,526
To :					
United Kingdom	581	563	792	193	71
United States	2,129	3,837	4,286	3,142	4,384
Canada . . .	—	—	—	—	71
Distilled :					
Total <sup>1</sup> . . .	8,970	8,494	9,377	8,606	10,030
To :					
United Kingdom	536	813	1,393	95	1,018
United States .	8,434	7,681	7,205	8,511	8,810
Canada . . .	—	—	779	—	202
<i>Grenada</i> :					
Total <sup>1</sup> . . .	952	1,125	2,457	8,019	(a)
To :					
United Kingdom	952	1,125	2,457	7,846	(a)
United States	—	—	—	173	(a)
TRINIDAD AND TOBAGO					
Total <sup>1</sup> . . . . .	(b)	934	3,728	900	4,282
To :					
United Kingdom	(b)	934	2,708	865	(a)
British West Indies .	(b)	—	631	—	(a)
United States . . .	(b)	—	389	35	(a)
BRITISH GUIANA					
Total <sup>1</sup> . . . . .	3,426	2,646	2,396	3,361	3,806
To :					
United Kingdom . .	3,426	2,646	2,396	2,049	3,806
United States . . .	—	—	—	312	—

(a) *Figures not available.*(b) *Not shown in Trade Returns.*<sup>1</sup> *Converted from gallons into lb. assuming 1 gall. = 8.65 lb.*<sup>2</sup> *Converted from gallons into lb. assuming 1 gall. = 8.8 lb.*

TABLE IV. EXPORTS OF CITRUS OILS—*continued*3. *Exports of Orange Oil*

—	1924.	1925.	1926.	1927.	1928.
	lb.	lb.	lb.	lb.	lb.
LEEWARD ISLANDS					
<i>Dominica:</i>					
Total . . . .	1,319	2,278	805	2,638	(a)
To:					
United Kingdom .	—	140	—	35	(a)
United States	1,319	2,067	770	2,503	(a)
ST. LUCIA	gallons.	gallons.	gallons.	gallons.	gallons.
Total . . . .	—	1	$\frac{1}{2}$	—	—
To:					
United Kingdom	—	1	—	—	—
United States .	—	—	$\frac{1}{2}$	—	—
JAMAICA	lb.	lb.	lb.	lb.	lb.
Total . . . .	84,453	103,519	64,000 <sup>1</sup>	88,000 <sup>1</sup>	(a)
To:					
United Kingdom	(a)	21,027	(a)	(a)	(a)
Canada . . . .	(a)	2,900	(a)	(a)	(a)
United States .	(a)	79,142	(a)	(a)	(a)
ITALY					
Total . . . .	279,548	263,049	278,228	303,568	287,483
To:					
United Kingdom	40,034	37,393	31,200	(a)	(a)
France . . . .	47,499	52,810	61,189	(a)	(a)
Germany . . . .	22,798	20,642	26,385	(a)	(a)
Netherlands .	18,201	21,874	5,990	(a)	(a)
United States .	131,107	110,926	129,094	(a)	(a)

4. *Exports of Bergamot Oil*

ITALY					
Total . . . .	354,228	391,100	336,771	379,621	412,361
To:					
United Kingdom	46,623	50,548	55,530	(a)	(a)
France . . . .	165,199	159,198	136,563	(a)	(a)
Germany . . . .	32,800	37,289	33,455	(a)	(a)
Netherlands .	12,535	15,406	10,593	(a)	(a)
United States .	55,045	80,916	72,614	(a)	(a)

5. *Exports of Mandarin Oil*

ITALY					
Total . . . .	8,834	11,964	12,897	19,317	18,104
To:					
United Kingdom	2,068	2,055	1,929	(a)	(a)
France . . . .	1,817	2,809	2,835	(a)	(a)
Germany . . . .	562	564	648	(a)	(a)
Australia . . . .	522	661	170	(a)	(a)
United States .	3,261	4,147	6,506	(a)	(a)

(a) *Figures not available.*<sup>1</sup> *Production.*

## APPENDIX

MANUFACTURE OF CITRATE OF LIME  
(CALCIUM CITRATE)

THE following particulars have been kindly supplied to the Imperial Institute by Messrs. Kembell, Bishop and Co., Ltd.

In preparing citrate of lime from lemons the skins are removed and squeezed on a sponge to extract the essential oil and afterwards are put into brine and exported for the manufacture of candied peel. The inside of the lemon, which is so skilfully peeled that it is still firm and solid, is crushed in a press to extract all the juice possible.

In the case of limes in the West Indies, the skins of the fruits are not removed, the fruits being crushed whole, either with or without previous "écuellage."

The juice which is obtained by crushing is run through a strainer so that it is practically clear, as any pulp left in the juice spoils the subsequent filtration and washing of the citrate of lime. Moreover, if pulp is left in the citrate of lime it will be impossible to get a really high percentage of citric acid.

The neutralisation of the juice is best effected by means of whiting or chalk. Whiting is made from chalk crushed under water; it is extremely fine. Chalk in most cases is quite satisfactory, but it requires crushing and should be sifted to remove any lumps. The latter are liable to be unacted on by the weak acid, and will remain in the citrate, lowering the percentage of citric acid and causing loss to the citric acid manufacturer.

Limestone and coral, although consisting of carbonate of lime, like chalk or whiting, are usually so crystalline and hard that they are unable to finish the neutralisation of lemon juice. Very fine grinding might, however, get over this difficulty.

The vessel usually employed for the neutralisation of the juice by whiting or chalk, is a tub, say 10-12 ft. in diameter and 5-6 ft. high. The tub is provided with an agitator the full diameter of the tub, about 1 ft. high and 3 in. thick. The agitator should make 14-16

revolutions a minute, and should always be right at the bottom of the tub.

These big agitators should be so made that they can be pulled up in their bearings, in order that in an emergency they can be raised clear of the solid matter in the tub ; otherwise, they may become stuck and have to be dug out. After the trouble is past, they can be lowered again gradually until they are in their proper position as near the bottom of the tub as possible.

After a little water has been placed in the tub, all the whiting is put in with the agitator revolving, and a steam jet is started to heat the mixture ; when the temperature has been raised to 150° F. the juice is run in, taking care that the liberated carbon dioxide does not cause the tub to overflow.

So long as there is brisk effervescence more juice is necessary. Juice should be added cautiously until a hot sample from the tub gives only a faint effervescence with a little sulphuric acid, thus showing that the amount of whiting left is very small.

To make sure that citric acid is not in excess, a sample of the hot mixture should be tested with a little whiting mixed into a " cream " with water. This is better than using dry whiting to show up traces of excess of acid.

The temperature is now raised to 180° F., and if the test with sulphuric acid still shows a faint effervescence and the test with " cream " of whiting shows a negative result the mixture can be filtered.

The filter may be a shallow tank with an outlet from the bottom, with loose strips of wood laid on the bottom, and a cloth supported on the strips and coming to the top of the tank at all the four sides. The strips of wood keep the cloth off the bottom of the tank and so allow the liquor to run freely into the chamber thus formed, to the outlet of the tank and thence to the drain.

The facility with which the waste liquor will filter away from the citrate of lime depends on the degree of excellence obtained in filtering the juice, and also on the quality of the whiting or chalk used. As these factors vary, it is difficult to suggest the proportions of the tank. It should, however, hold all the charge at once, which

may be as much as 3,000 gallons ; perhaps 14 ft. by 20 ft. by 2 ft. deep would be suitable. It is necessary to ensure that the liquor shall drain rapidly, before it gets at all cold. Citrate of lime is distinctly more soluble in cold than in hot water ; cold liquor or water, therefore, means a loss of citrate in the water drained away.

It is always advisable to wash out as much as possible of the liquor that remains in the cake by means of hot water. If the citrate is only drained, it leaves a good deal of impurity in it.

After allowing all moisture possible to drain out of cake, the wet mass is cut off the cloth and dried. This can be done in rooms with shelves heated by steam pipes, or even by fires, but there must be plenty of ventilation so that the water vapour is carried away in the air. Citrate will come to no harm up to 300° F.

It is most important that the citrate should be dried quickly as it decomposes rapidly when damp. The decomposition converts the calcium citrate into calcium carbonate and what was once a good citrate may rapidly become a bad citrate with low citric acid content and high calcium carbonate content.

As whiting is in excess in the tub, from the beginning to the end of the process, no acid can be present to attack the iron spindle of the agitator, etc. Too great an excess of whiting, however, reduces the citric acid content and is therefore objectionable.

In cases where neither whiting nor other suitable form of carbonate of lime is available, quick-lime, made by burning limestone in a kiln, may be used, but the process as described above must be modified to some extent.

In this case the acid juice must go into the tub first and iron-work is therefore liable to suffer. To prevent this it is usual to cover the spindle, etc., with lead.

The juice is heated and quick-lime (which has been previously slaked with water to a thin cream) is added. It must not be added in excess, if the best citrate is desired, because excess of lime brings down iron and other impurities.

If by accident too much slaked lime is added, so that the mixture turns litmus blue, a good excess of juice must

be added to get it sharply acid again, and it should be allowed to stay acid for say half an hour to take up the iron, etc., precipitated. After this, lime is again added more cautiously.

The final test is when a sample of the hot mixture will give very little or no effervescence with "cream" of whiting, and at the same time is acid or neutral to litmus.

The rest of the process is exactly as described before.

The purity of the chalk, or other form of limestone, used for neutralisation is of great importance. Iron, alumina, phosphoric acid and magnesia must be only present in traces. All these harm the product and produce loss. If magnesian limestone (dolomite) were used, possibly one half of the total citric acid would be lost in the draining water.

Some citrates drain very poorly on an ordinary filter, and they hold so much water that they are very difficult to dry. There are two possible ways of overcoming this, but both require apparatus. One is to use a vacuum filter instead of an ordinary filter, and the other is to replace the filter by a filter press, into which the mixture can be pumped at high pressure. Judging by the appearance of some of the citrates from Sicily, the latter method is probably that at present employed in that country.

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## NOTES

**Forest Products Research in the United Kingdom.**—It became evident during the war that the conservation and development of timber resources in the United Kingdom would be a post-war problem of great importance. The Forestry Commission was created to deal in the main with the production side of the question, and the Forest Products Research Board was established under the Department of Scientific and Industrial Research in 1921 to deal with the utilisation of forest products; Mr. R. S. Pearson, C.I.E., formerly of the Indian Forest Service, was appointed as Director of Research in 1925, and a Laboratory was opened at Princes Risborough in 1927.

*The Report of the Forest Products Research Board for*

*the period ended September 30, 1928* (London: H.M. Stationery Office, 1929, price 3s.), contains a résumé of the activities of the Board since its inception and an account of the work of the Forest Products Research Laboratory. The primary purpose of the Laboratory is to promote the economical utilisation of timber. This involves, for example, the specification of the most economical sizes determined by knowledge of the strength factors, the investigation of the possibilities of new timbers and the adaptability to new purposes of known timbers, and the study of improvements in seasoning processes and methods of preventing decay.

The organisation of the Laboratory is planned to secure co-ordination between the different interests concerned. The Wood Technology Section is at the Imperial Forestry Institute at Oxford, and liaison is maintained with the research work on forest crop production carried out at that Institute. There is also close touch with the Imperial College of Science and Technology, where the Mycology Section is housed; and in order to ensure a free interchange of ideas with builders, architects, timber merchants, and the timber-using industries generally, the officer in charge of the Utilisation Section of the Laboratory is a member of the Imperial Institute Advisory Committee on Timbers.

For particulars of the work carried out by the Laboratory reference must be made to the Report; it is only possible to indicate here the nature of the work by enumerating the headings under which it is dealt with, namely: wood technology, timber physics, seasoning, timber mechanics, wood preservation, wood-working, mycology, entomology, wood chemistry and utilisation.

**Walnut Woods.**—A valuable account of the various timbers marketed under the name of "Walnut" is given by S. J. Record in *Tropical Woods*, 1929, No. 18, pages 4-29. Such woods are to be classified as true and false walnuts, and the author points out that genuine walnut timbers are exclusively the product of a single genus (*Juglans*) belonging to the small natural family, *Juglandaceæ*, of which only one other member (*Hickory*, derived from *Carya* or *Hicoria*) yields a commercial timber. The great bulk of true walnut is derived from two species, namely, *Juglans regia* L., the source of Circassian, French, Italian and English walnut, and *J. nigra* L., the American black walnut. The Butternut (*J. cinerea* L.) ranks a poor third. The author considers the eastern slope of the South American Andes to be the most promising new

source of genuine walnut. The wood of *J. boliviana* Dode closely resembles American black walnut.

Among the timbers referred to by the author as "woods improperly called walnut" are American red gum or gumwood (*Liquidambar Styraciflua* L.) belonging to the family Hamamelidaceæ, the heartwood being known in the United Kingdom as "satin walnut"; African walnut (*Lovoa Klaineana* Pierre), a member of Meliaceæ or mahogany family; Australian walnut, known in the United States also as "oriental walnut" (*Endiandra Palmerstoni* (Bail.) C. T. White), belonging to the laurels (Lauraceæ); the Imbuia (recently identified as *Phæbe porosa* (Nees) Mez. belonging to Lauraceæ) of Southern Brazil sometimes sold as Brazilian walnut in the United States; species of *Cordia* (Boraginaceæ), especially those occurring in the tropics of the New World and notably the freijo (*C. Goeldiana* Huber) of Brazil which has been marketed in the United States as South American walnut, Brazilian walnut or jenny wood; East Indian walnut (*Albizzia Lebbek* Benth.) derived from Leguminosæ; guanacaste (*Enterolobium cyclocarpum* (Jacq.) Gris.) from a leguminous tree of Central America and known in British Honduras as "tubroos"; Congo walnut or noyer de Mayombe, the heartwood of the "limbo," *Terminalia superba* Engl. and Diels, belonging to Combretaceæ and occurring in the Cameroons and British West Africa, but abundant also in the Congo; and Honduras walnut or black poison wood (*Metopium Brownei* (Jacq.) Urban), belonging to Anacardiaceæ.

**The Utilisation of Para Rubber Seed.**—For many years past the possibility of utilising the seed of the Para rubber tree produced on the plantations in the Middle East has been under consideration. Numerous references will be found in this BULLETIN to the investigations which have been made to utilise the seed as a source of oil and feeding-cake and in 1919 a full account of the results up to that time was published (Vol. XVII, No. 4, pp. 543-71).

According to an article in the *Malayan Agricultural Journal* (1929, 17, 39), the question of marketing rubber seed produced in Malaya has recently received renewed attention owing to the offer of an American Corporation to purchase the seed at 22 Straits dollars per ton f.o.r., sacks being provided by the Corporation. The seed collected is exported to Belawan in the Dutch East Indies, where it is decorticated; the kernels are dried and chemically treated to destroy enzymes and afterwards bagged and shipped to America for the extraction of the oil.

Last year 7,905 tons of seed were exported from Malaya, valued at 246,940 dollars. As a divergence of opinion exists among planters as to whether the seed can be marketed profitably at this price, the Department of Agriculture has undertaken an independent investigation, with the concurrence of the Rubber Research Institute. For this purpose statistics and other information were collected from thirty-six estates who were engaged in the collection and export of rubber seed in 1928. From these data, it is estimated that 10 acres of plantations will yield on an average 1 ton of seed per annum, and that 100,000 tons of seed can be economically marketed every year. The amount of seed available will naturally vary with the season. The cost of collection varied from 6 to 14 dollars per ton with an average of 9.30 dollars. Packing costs on an average 87 cents per ton. Care has to be taken to see that the consignments are free from any large proportion of empty or dirty shells, defective seeds and foreign matter, such as earth, in order that the necessary certificate of freedom from pests and diseases may be obtained, without which entry into the Dutch East Indies is impossible. This supervision costs 88 cents per ton. The charges for transport to the railway naturally vary according to the location of the estate, and were found to range from 26 cents to 7.50 dollars per ton, with an average figure of 2.61 dollars. The figures quoted show that the average cost for the collection and marketing of a ton of rubber seed is 13.66 dollars which represents a profit of 67 per cent. Besides the monetary profit that will accrue through the prosecution of this scheme, the marketing of rubber seed will have the advantage that it will tend to keep a contented labour force by providing work for women and children, which is generally a problem on an estate where Indian labour is employed. The following conclusions are drawn from the results of this investigation : (1) The marketing of rubber seed, at present prices, is profitable provided that transport charges are not prohibitive, that the estate has a settled labour force, is clean weeded and not too steep, and that there are not more remunerative forms of spare time employment for the coolies. (2) The average cost of production allows a profit of over 50 per cent. to the estate. (3) The work is popular amongst labourers and their families, who are thus able to add considerably to their wages. (4) Planters have gained valuable experience during the past season in marketing rubber seed, and it is anticipated that improved returns will result in future seasons from a closer supervision of the collection.

## RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government  
Technical Departments Overseas

## AGRICULTURE

## SOILS

**Ceylon.**—According to the *Annual Report of the Department of Agriculture* for 1928, a manuscript copy of which has been furnished to the Imperial Institute, the subject of soil erosion continued to engross attention during the year, and there has been much discussion of the merits of various systems of preventing or controlling erosion. Prevention of erosion from the time of clearing is undoubtedly the ideal to be aimed at, and it is apparent from the work that has been done on certain estates that a useful degree of prevention can be attained by the adoption of particular systems. The question of the planting of cover crops on new clearings and their draining and contour terracing requires much attention.

The soil erosion experiment on the Experiment Station, Peradeniya, in which records are kept of weights of soil lost, has been continued. The results to date show that large amounts of soil are lost, but they do not indicate the superiority of one line of soil treatment over another as a preventive of wash. The experiment will be continued for several years. In the meantime, analyses are in hand from which it is hoped to obtain a rough estimation of the amount of soil colloids removed by the flow from the plots and also information regarding changes of constitution of the soils that may take place while erosion proceeds.

## MANURES

**Ceylon.**—According to the *Annual Report of the Department of Agriculture* for 1928, the Agricultural Chemist has continued his field experiments on the decomposition of green manures. His results show that on the whole envelope-forking of green manure material into the soil tends to increase the nitrogen content of the soil to a greater extent than leaving the material on the surface. It was also ascertained that nitrogen was lost through the practice of leaving the loppings of green manure plants and tea prunings to dry in the field before forking them in. The losses of nitrogen vary with different plant materials

and also with the weather, being particularly large under alternate wet and dry conditions. It was shown that at the end of a period of drought, soil which has had the loppings of green manure trees dug in contains more moisture at all depths up to 24 inches than the soil of control plots or the soil of plots with green manure trees which have not been lopped. Similar results were obtained in the case of bushy green manures. In the case of creeping green manure plants moisture was much greater in the soils of both cut and uncut green manures than in the soil of the control plots.

An investigation of the decomposition of green manuring material under anaerobic conditions such as hold in paddy cultivation was undertaken by the Chemist in co-operation with the Economic Botanist. The purpose of the investigation was the practical one of determining the optimum time of incorporating green manures with paddy soils. Conclusive results have not yet been attained, but it is indicated that late burying is preferable to early burying. Similarly, laboratory work on the changes in the nitrogen and humus content of paddy soils shows that the addition of green manuring material at the time of puddling the soil is preferable to the practice of manuring six weeks before puddling is done.

On April 1, 1928, an experiment was begun in the Bandaratenne rubber section of the Experiment Station to show how the cutting and forking in of *Vigna* twice a year affects the yield of the treated area in comparison with an uncut and unforked area of *Vigna*. In one rubber plot mixed seed of *Centrosema pubescens* and *Calopogonium mucunoides*, which was sown several years ago, has failed to form a cover. On the other hand, *Centrosema pubescens* has made good growth in the unshaded contour terraces of the Iriyagama Division. A promising indigenous cover plant, *Dunbaria Heynei*, is under trial at the Kogalle Experiment Station of the Central Division.

The Agricultural Chemist has continued his investigation of the leaching of fertilisers under local conditions. The following is a summary of results in respect of the amounts of drainage :

(1) The average drainage from the uncropped plots is greater than that from the cropped plots, being about two-thirds and two-fifths of the annual rainfall respectively.

(2) The amounts of drainage from the different plots vary, being lowest from the nitrate of soda plots and highest from both superphosphate plots and the muriate of potash uncropped plot.

(3) The amount of drainage is directly correlated with

the rainfall and, under certain conditions, appears to be dependent on the intensity of the latter.

(4) There is no direct relation between drainage and soil temperature.

The results as regards the *composition of the drainage waters*, were as follows :

(1) Calcium oxide (lime) and nitrates are present in largest amounts, chlorine to a lesser extent, and potash in much smaller proportions. No appreciable quantities of phosphoric acid or ammonia are present.

(2) The large amounts of lime and nitrate found in the drainage waters are due to the soil disturbance. The addition of nitrogenous fertilisers to the plots at the rate of 60 lb. of nitrogen per acre does not appear to have influenced either the total amounts of nitrate nitrogen or the concentrations of nitrate in the drainage waters.

(3) There are much smaller amounts of fertilising constituents in the drainage waters from the cropped than from the uncropped plots. Towards the latter half of the year, the amounts of fertilising constituents found in the drainage waters from the former were small.

(4) The amounts of soluble constituents in the drainage waters are almost directly proportional to the drainage and hence the rainfall.

(5) The smallest amounts of nitrate nitrogen in the drainage waters are found in the nitrate of soda plots and the largest in the cyanamide plots.

Laboratory and field experiments on the nitrification of manures and fertilisers, also carried out by the Agricultural Chemist, have led to the following conclusions :

A. (1) The first period of maximum nitrification varies from the sixth to the eighth week as found in previous experiments.

(2) High nitrification percentages are obtained in all cases. This may be the result of the optimum moisture and temperature conditions under which the experiment was carried out, or of the mineralisation of some of the soil humus, or the result may be due to a partial failure of the modified phenol-disulphonic acid method for nitrates adopted in this investigation.

(3) There is a secondary nitrification obtained in all cases after periods varying from the twelfth to the fourteenth week, to an even greater extent than the primary nitrification.

B. Field nitrification tests carried out with the more widely-used nitrogenous fertilisers and manures, though not furnishing such definite data as the laboratory experiments owing to the effect of rainfall on the amounts of

nitrate in the plots at the times of sampling, gave much the same results as the latter experiments regarding the period of maximum nitrification and maximum percentages nitrified. Soils from the plots containing concentrated nitrogenous fertilisers generally showed larger amounts of nitrate in the soil each time a sampling was made. These fertilisers gave smaller nitrification percentages. The direct effects, from the nitrogen standpoint of all fertilisers and manures do not appear to be manifest after the fourth and fifth month under the soil and climatic conditions of Peradeniya. The above conclusions are identical with those obtained from the green manure laboratory and field experiments carried out previously.

#### COVER CROPS

**Somaliland.**—Mr. R. A. Farquharson, Director of Agriculture, reports that cowpeas and kulthi (*Dolichos biflorus*) were tried with a view to their use in the cultivation of a mixed crop, as a soil improver, as a green manure, and as a green feed for stock in jowari gardens, after the jowari has been harvested.

Both species grew extremely well, up to the end of May, but from that time owing to the poor rainfall the crop fell away. It may be mentioned, however, that the cowpea seed, which was obtained from India, was infested with grain bugs, and, though some selection of the seed was made, the results could not be expected to be as good as with fresh unaffected seed.

Kulthi planted as a soil improver in the orchard plot grew excellently when provided with a fair amount of water, even in the dry season, and it is fairly certain that in a normal season, both varieties would be successful as a mixed crop with jowari.

They will be tried in this way next year.

**Tanganyika.**—Trials with *Centrosema pubescens* and *Passiflora foetida* were continued at the Mpanganya Agricultural Station. The former again showed its unsuitability to local conditions, while *Passiflora foetida* again gave a thick growth impenetrable to weeds, and a high resistance to drought. Last season's planting was left to see the effects of a second year; with the short rains it quickly recovered and made heavy growth, but two years would appear to be the maximum effective growth of this plant. New sowings were also made, and these, as in the previous year, required careful weeding for one month until established, after which the crop was able to compete and smother all weed growth, including the sedge

grass "dago," *Cyperus rotundus*. No weeding has been required over twelve months, and no weeds of any description are visible. The seed contains a hard glutinous coat, and so requires soaking for 24 hours before sowing to obtain quick germination, or equally good results are obtained if freshly gathered berries, which contain several seeds, are sown direct.

#### FUNGOID DISEASES

**Ceylon.**—According to the *Annual Report of the Department of Agriculture* for 1928, investigations into the causes of root disease of woody plants with special reference to *Rhizoctonia bataticola* have brought out the interesting and probably significant facts that the fungus occurs in a mycorrhizal form in healthy rootlets of tea, and that it also occurs in the larger roots of apparently healthy plants of tea and rubber. The investigations and inoculation experiments with *Rhizoctonia* are in progress.

#### INSECT PESTS

##### *Locusts*

**Somaliland.**—Mr. R. A. Farquharson, Director of Agriculture, reports that during July and August large swarms of locusts swept over the Protectorate. During July they did considerable damage, but during August, when the swarms were larger and much more voracious, pastoral areas were denuded, trees of all kinds were stripped, and in agricultural areas, between Hargeisa and the vicinity of Buramo, every standing crop was completely devastated. Owing to the grave menace to native stock and agriculture, on the return of the Director from leave, the preliminary measures to be adopted with the object of controlling the pest had early to be considered. The questions of immediate importance were :

Whether the swarms were a visitation from outside the Protectorate ; whether they originated from egg-laying grounds inside the Protectorate ; whether the insects were identical with those already recognised as a menace in contiguous countries ; whether locusts in large numbers in the small and larger hopper stages had been observed in the Protectorate, and in what districts. While in the Erigavo and south-eastern Burao districts, the Director himself at the end of the year observed large numbers of the insects at or about the egg-laying stage, and large swarms of young hoppers. Reports were also obtained

of the presence, during May and June, of large swarms of hoppers on the southern boundary, west of Bohotleh.

As an essential preliminary to effective methods of coping with the insects during the incoming year, steps were taken to institute an efficient intelligence system. This system, its operations and results, and the measures based on it are matters to be set out in the report for 1929.

### *Termites*

**Ceylon.**—According to the Annual Report of the Department of Agriculture for 1928, the most important entomological work undertaken during the year was the investigation of the termites of tea and other plants. Much information has been acquired concerning the bionomics and distribution of the pests, and the Entomological Division is now in a position to advise regarding both prevention of attack and control of the insects by destruction of the colonies.

## CEREALS

### *Bulrush Millet*

**Tanganyika.**—At the Mpanganya Agricultural Station local types of bulrush millets, which have a small grain, were sown for a second year in trial with the bolder grained varieties of Tabora and Dodoma, with the following results :

Variety.	Comparative yields.	
	1928.	1927.
Dodoma . . . .	67 (III)	21 (VIII)
Tabora . . . .	100 (I)	—
Mkula . . . .	71 (II)	85 (II)
Kisago . . . .	55 (V)	100 (I)
Lumbururu . . . .	42 (VII)	58 (VII)
Ruhonyo . . . .	33 (IX)	61 (VI)
Kukwili . . . .	51 (VI)	71 (V)
Nyakhuki . . . .	64 (IV)	77 (IV)
Nyamototi . . . .	36 (VIII)	80 (III)

The Dodoma and Tabora varieties matured twenty days earlier than the local types. Both kinds should be valuable introductions to the hill-lands, especially the more dwarf Tabora type ; the Dodoma variety with its large thick head suffers badly from moulds in a season of

heavy rainfall, which accounts for its low yield in the 1927 season.

### *Maize*

**Tanganyika.**—Two introduced varieties of maize, Potchefstroom Pearl and White Congo, were grown at the Morogoro Experiment Station alongside the local native maize more as a demonstration than an experiment. As the results of experiment with several varieties of maize in preceding years, it has been decided to adopt the heavy yielding white dent, Potchefstroom Pearl, as the variety for distribution in areas of good rainfall, and the quicker maturing, more drought-resistant flint variety, White Congo, for distribution in drier parts. The table below gives the yields obtained in this demonstration. All plots were planted on March 1, 1928.

Variety.	Yield per acre in kilos.	Days from planting to harvest.	Days from planting to flowering
Potchefstroom Pearl . . . . .	1,188	130	46
White Congo . . . . .	1,101	115	39
Local Native . . . . .	1,007	115	43

The following result obtained in a field where the crop was grown for the multiplication of seed are of value as giving yield under ordinary farm conditions rather than yield obtained in a comparative trial on small plots.

Variety: Potchefstroom Pearl.

Planted: February 19, 1928.

Harvested: July 3, 1928.

Area of field: 1 acre.

Actual Yield: 1,056.4 kilos. shelled grain.

It should be noted that the yields reported are obtained on the red soil of the Morogoro Experimental Station, which is not in a good maize area.

In an experiment on time of sowing carried out at Morogoro a departure was made from the previous practice of planting at definite weekly intervals. Planting was done at intervals of a week only if conditions appeared such as would give germination. Potchefstroom Pearl maize was used. The results of the experiment are shown on the next page.

It will be noted that the highest yields were given over a planting period of fourteen days, from February 20 to March 5. From a consideration of results it would appear that yield is dependent on early planting and rainfall. Provided rainfall is adequate early planting appears to give the best results. From a consideration of rainfall

Date of planting.	Rainfall.			Yield.	
	Month.	Milli-metres.	Number of rain-days.	Kilos. per acre.	Com-parative.
November 2, 1927	Nov.	34	—	2	0
" 22, 1927	—	—	—	1	0
" 28, 1927	—	—	—	nil	0
December 17, 1927	Dec.	150	—	nil	0
January 1928	Jan.	8	5	no planting	—
February 20, 1928	Feb.	57	15	1,416	100
" 27, 1928	—	—	(Commencing 15th)	1,031	73
March 5, 1928	March	77	9	1,065	75
" 12, 1928	—	—	—	370	26
" 19, 1928	—	—	—	217	15
" 26, 1928	—	—	—	440	31
April 2, 1928	April	215	18	270	20
" 9, 1928	—	—	—	157	11
" 16, 1928	—	—	—	82	6
" 23, 1928	—	—	—	42	3

statistics for this area, adequate precipitation cannot be expected before the middle of February. It would appear that the safest planting time is with the first good rains after February 15.

It may be noted that in the 1927 experiment the rainfall throughout the season was insufficient to mature a crop, whilst in 1926 the first planting was done in April and this planting gave the highest yield ; it was in consequence of this result that the experiment was planned to commence earlier in 1927 and 1928.

Trials of maize were also carried out at the Mpanganya Agricultural Station with Kenya hybrid, White Congo and two types of Potchefstroom Pearl. Plots of Kenya hybrid were damaged by elephants, whilst in the case of Potchefstroom Pearl the yields were insignificant owing to poor germination ; the results of the trials are thus of no value. It frequently happens that seed of an introduced crop has a poor germination capacity in the first year, which is often not seen in the second year from seed produced at the Station.

### *Millet (Panicum)*

**Tanganyika.**—In variety trials at the Morogoro Experiment Station three millets were grown, viz. two strains of proso millet (*Panicum miliaceum*), one from Poona and the other from South Africa, and *P. frumentaceum*. These millets are very quick-growing and were introduced to provide a quick-growing crop in the drier parts of the Territory. A trial planting in December 1927 was a

complete failure. The results of second planting on February 21, 1928, are given below :

Variety.	Days to harvest.	Yield per acre in kilos.
Poona Proso . . .	76	422
Station Proso . . .	76	463
P. frumentaceum . . .	91	508

While these millets would hardly be a useful addition to native food crops in this area of fairly high rainfall, it has been demonstrated that they are very quick-growing and produce a fair crop of grain. There is little to choose between the two strains of *Panicum miliaceum* either in yield or maturity. The grain of the Poona strain is more uniform, and has a deeper and more pleasing colour and general appearance. The *Panicum frumentaceum* grain is hardly likely to be acceptable to natives as a food crop except in years of food shortage.

A spacing experiment with the Poona strain of proso millet (*Panicum miliaceum*) was also carried out at Morogoro. All plots were planted on February 21, 1928. The results of the experiment are given below :

Distance of planting.	Acre yields in kilos.	Order of yield.
Broadcast at 15 lb. per acre . . .	370	II
" " 25 " " " . . .	305	V
Sown in drills 6 inches apart . . .	370	II
" " 12 " " " . . .	410	I
" " 24 " " " . . .	355	IV
" " 36 " " " . . .	167	VI

A similar experiment was carried out in 1927, but the results were too conflicting to form any conclusion. It would appear that sowing in drills one foot apart gives the best results in Morogoro, but this experiment to be of value should be carried out under the conditions of the areas in which the seed is to be distributed.

### Rice

**British Guiana.**—The following summary of the work on rice carried out on the Agriculture Station, Georgetown, is given in the *Administration Report of the Director of Agriculture for 1928*.

The more important lines of investigation related to (1) Variety trials ; (2) Seed selection ; (3) Rates of seedling ; (4) Cultural methods.

The bulk of the work under the first heading consisted in purifying the existing varieties at the Station and the introduction of others. The old varieties at the Station were so badly mixed that roguing had to be undertaken

on a large scale before accurate yield tests could be carried out. Data in respect to comparative yields will therefore not be available until 1929. The varieties cultivated in the Experimental Fields for many years include Demerara Creole, Nos. 75, 76, 77, 78, 79, H.6, H.7, Berbice Creole, Surinam Creole, McKenzie and Blue Rose. To these a number obtained locally were added during the year, including Hope Barley and Essequibo Blue Stick. Contributions were also received from Trinidad, India, Burma, Honduras, Canada, Hawaii, Ceylon and California. Thus at the end of the year the Station was in possession of a large and comprehensive collection of rices of varying types and showing distinctive characters as regards crop duration, yield, size and shape of grain, height of straw, milling qualities, etc.

Seed selection in addition to roguing out undesirables from seed plots consists fundamentally in the careful selection of individual plants exhibiting apparent superior characters and the comparative testing of their progeny, leading eventually to the isolation of improved strains within varieties and their multiplication for distribution to growers. This work entails the most careful nursery lay-out for a crop such as rice, in order that no mixing may take place in letting in or taking off water. A special system had therefore to be devised to meet this requirement. In this way, an original selection of 315 individual plants from the autumn crop of 1927 have been dealt with, and further selections made during the spring and autumn crops of 1928. During the progress of this work opportunity has been taken to make accurate observations on habits of growth, tillering, stiffness of straw, resistance to varying conditions of environment, etc.

Rates of seeding experiments have so far proved conclusively that the amount of seed used per acre locally can almost be halved, resulting in better seedlings being produced in the nursery with improved field yields. A nursery seed rate of 7 lb. to the square rod (12 ft. 4 in.  $\times$  12 ft. 4 in.) can be confidently recommended, and at this rate 35 lb. of seed will be ample to plant an acre of rice, two or three plants being put to each hole when transplanting. Using a small number of robust seedlings induces increased tillering which results *inter alia* in heavier returns. These experiments are being continued while other related factors will be studied at the same time.

Cultural methods with the crop have included observations on the effect of more thorough cultivation and

puddling to suppress undesirable volunteer rice (principally "red" and "bearded" sorts). In this connection, the beneficial effect of complete flooding for some time of beds badly infested with inferior rices from previous crops, prior to planting the new crop, has been most marked. Light animal-drawn implements for rice work are also being investigated.

**Ceylon.**—According to the *Annual Report of the Department of Agriculture for 1928*, the paddy selection work of the Economic Botanist was extended during the year by the addition of two central paddy areas at Labuduwa (Galle) and Wariyapola to those already in existence at Peradeniya and Anuradhapura. The function of the central paddy areas is the initial multiplication, testing and maintenance of purity of the selections made by the Economic Botanist, and the primary work of the paddy seed stations is seed multiplication and the conducting of varietal trials. The paddy seed stations, which now number twenty-three, are under the charge of the divisional and district officers. During 1928, 330 new selections were made, and about 500 selections were discarded after field trials. Seed of good selections is distributed to cultivators after two field trials in a given district, but the trials are continued in the paddy seed stations in order that they may yield data on the response of the selections to seasonal variations of climate. The work at Anuradhapura was interfered with by lack of water.

The field trials of the maha season of 1927-28 and the yala season of 1928 showed that with very few exceptions the selections were superior in yield to local paddies. The results were closely scrutinised and were found to be statistically significant and not caused by chance. The divisional officers report that the cultivator is showing an increased interest in paddy field trials and a desire to acquire seed of proved selections.

The first permanent manurial trials with paddy were laid down during 1928 at Peradeniya and at Labuduwa. The first season's results are not yet available, and the trials will be continued until seasonal variations can be eliminated from the results and the profitableness or otherwise of applying manures is definitely established. Sulphate of ammonia, superphosphate, potash, ammophos, steamed bone meal and green manures are being tested singly and in combination. Steamed bone meal appeared to give promising results in a preliminary experiment at Peradeniya. Two green manuring experiments were failures owing to wet weather at harvest time. Green

manuring trials at Peradeniya have met with little success. The following plants have been tried : *Crotalaria anagyroides*, *Crotalaria juncea*, *Crotalaria usaramoensis*, *Sesbania cannabina*, *Desmodium gyroides*, *Mucuna* and *Tithonia diversifolia*.

A Japanese threshing machine was tried at Katugastota with encouraging results. The trials will be continued, but, in the meantime, several cultivators who saw the machine in operation have bought or ordered it.

**Tanganyika.**—In a report on the Mpanganya Agricultural Station for the year ended March 31, 1929, it is mentioned that the Territory contains varieties of rice which in yield compare well with the rices of other lands. The average yield of paddy under native cultivation throughout the Rufiji District over the past four years is 1,536 lb. per acre under an average annual rainfall of 816 millimetres, whilst in the Federated Malay States the yield in a good year of 1,980 millimetres rainfall was 1,128 lb. The greater part of the East African rice crops are dependent on rainfall, temporary flooding of the land being a matter of chance over all but comparatively small areas, while in the Malay States controlled flooding is widely practised. Yet in the multitude of types to be found throughout the Territory there are many of little value, often maintained only by a traditional sentiment, such as Afa, which was widely grown comparatively recently, but is now a poor yielder with little resistance to drought, and which, with a conservatism common to farmers the world over, is still grown by the older natives. Other types, while having both low yield and commercial value, are soft rices which cook well and have an appeal peculiar to localised areas, such as Kilowae, a soft rice popular to the Kikale region of the Eastern Rufiji, and also Kimoto. The trials conducted at the Mpanganya Station are designed with a view to giving a basis of knowledge by which an improvement can be attained by elimination of the poorer types and substitution with more suitable kinds both as regards yield and market value.

The comparative results of the trials, together with the order of yield for past years are given in the table shown on p. 354, and these should be considered in conjunction with the rainfalls of the different years which are 631 mm. for 1928, 1,120 for 1927 and 746 for 1926.

With the exception of variety Pa D.C. which was obtained from the Gold Coast, all the above varieties of rice were obtained from native cultivations in the Rufiji.

Variety.	Compara- tive yield.	Order of yield.			Keeping quality of paddy.
		1928.	1927.	1926.	
Afiri (U.) . . . .	100	I	III	VII	F.
Mwanga (U.) . . . .	86	II	XVII	XII	G.
Bungala (U.) . . . .	84	III	XIV	—	VG.
Marula (U.) . . . .	82	IV	XV	III	F.
Hebu (U.) . . . .	79	V	XXI	XVI	P.
Africa (U.) . . . .	76	VI	III	II	F.
Ngowe (U.) . . . .	76	VI	VII	IV	G.
Meno Meupe (U.) . . . .	76	VI	XI	I	P.
Komamanga (U.) . . . .	72	IX	VI	VI	P.
Kilowae (U.) . . . .	71	X	XX	X	P.
Almeri Mgeni (U.) . . . .	70	XI	XI	VIII	VG.
Kichawachawa (U.) . . . .	65	XII	XIII	IX	P.
Kilimali (U.) . . . .	58	XIII	IX	V	VG.
Unyengwa (H.) . . . .	57	XIV	XVIII	XIII	G.
Ngukukuru (H.) . . . .	57	XIV	—	—	G.
Kanunge (L.) . . . .	57	XIV	II	—	P.
Pa D.C. (L.) . . . .	55	XVII	—	—	?
Borakupata (H.) . . . .	54	XVIII	—	—	G.
Bilgili (U.) . . . .	53	XIX	—	—	P.
Jegerenati (U.) . . . .	52	XX	VIII	XI	VG.
Maridadi (U.) . . . .	50	XXI	I	—	VG.
Stima (L.) . . . .	48	XXII	V	—	G.
Mpemba (L.) . . . .	38	XXIII	XIX	XIV	G.
Msamaki (L.) . . . .	28	XXIV	XV	—	VG.
Afa (L.) . . . .	22	XXV	IX	XVII	G.
Kimoto (L.) . . . .	14	XXVI	XXII	XV	G.

U. = Upland or dryland rice.

P. = Poor.

L. = Lowland or marsh-land type.

F. = Fair.

H. = Hill-land type.

G. = Good.

VG. = Very good.

A feature further indicating the need of reorganisation of the cultivation of rice in this district, is the low yield of the lowland varieties even in the year 1927 of record high rainfall, the poorest of these types being Mpemba, Stima, Msamaki, Afa and Kimoto. The comparative low places in yield of the hill-land varieties Unyengwa, to which so much importance is attached, Borakupata and Ngukukuru, indicate the need of a period for acclimatising, and with these, plant selection will help to bring them to a higher state of yield capacity.

The ideal system to give increased and improved rice cultivations would be for the early plantings to be made with an upland type (that is intermediate between true lowland and so-called hill-land) such as Afiri, which is a close relative of Africa, or Mwanga or Bungala, with late plantings of an improved hill-land type such as Unyengwa. The two harvests would coincide as the latter type is of shortest "age," and loss through birds would thus be at a minimum; the general failure of the native rice crop would then be rare.

Of the lowland types, Kanunge is outstanding and worthy of further investigation ; it is the most popular rice of the delta, where conditions are more truly lowland. Maridadi, although regarded as an upland type, appears to be more of a lowland character.

In the interpretation of the results it must be remembered that the proper spacing and careful cultivation of the trials tend to a higher yield with the lowland type and many upland varieties than would occur with the poorer cultivations followed by the native grower, and conversely, the hill-land and true upland types would be more outstanding under native conditions. Mention should be made of the introduced variety Pa D.C. which, although described as a marsh-land type, proved suitable to drier land conditions ; it is heavy bearing with a grain superior in appearance to the local kinds, and should by plant selection prove a valuable addition.

The great diversity of types of rice, mentioned above, considerably depresses the commercial value of the crop. The deltal area has fewer types than the central valley, due to its peculiar conditions, and its rices have a premium of 3 per cent. over the other areas of the district, the product placed on the market by the local buyers being more uniform with less waste in milling. In the improvement of the rice crop no co-operation can be expected from the local buyer who has not storage room for keeping separate the many kinds of rice he buys from the grower. The only solution is through the grower, and to eliminate what one may term the sentimental types, it will be necessary to produce a rice which in addition to being of good quality, suited to the popular taste and capable of long storage, must be of such high yield that a wide demand for its seed will follow demonstration in agricultural substations and co-operative plots.

The rice trials have now reached the point where this can be attempted by single plant selection for the production of pure lines, and keeping the erratic rainfall of the coastal climate in view, the points leading to the choice of any single plant are :

(a) To make the crop as independent of water supply as possible, by selecting plants from upland and hill-land varieties, which show an unusual resistance to drought conditions, with early maturity.

(b) To ensure against seasons of heavy rainfall by the selection of strong strawed plants.

(c) Heavy yield, long keeping quality of grain and good taste are imperative.

It is realised that rice can be acclimatised to suit any

conditions within reason, and rice being a water-loving plant, it is obvious that the above requirements will be more easily met by selecting from upland and hill-land types. At the same time it may be possible to obtain an unusual plant from a marshland type which has the desired qualities, but such a plant would most probably be a "sport," and the odds are against this occurring in experimentation, but should be possible of obtaining if widely sought amongst native cultivations. Nevertheless, selections have been made of single plants from all the three main types, and from the trials of 1928 the following selections were made :

No. 1/28.	Selection from Hebu.	
No. 10/28.	" "	Almeri Mgeni.
No. 20/28.	" "	Komamanga.
No. 30/28.	" "	Unyengwa.
No. 40/28.	" "	Bungala.
No. 50/28.	" "	Mwanga.
No. 60/28.	" "	Pa D.C.
No. 70/28.	" "	Borakupata.
No. 80/28.	" "	Meno Meupe.

Over 100 selections were made, but after detailed examination all but the above were discarded, and of these the Mwanga, Bungala, Unyengwa and Almeri Mgeni are the most promising.

### *Sorghum*

**Somaliland.**—Mr. R. A. Farquharson, Director of Agriculture, reports that two varieties of Indian jowari were planted, Sholapuri and Nialo. Unfortunately, owing to the unavoidably crude storage arrangements, the seed was badly attacked by grain bugs before sowing, and, consequently, a good stand could scarcely be expected, even after heavy sowing. The seed germinated well, and both varieties were in good condition, despite the small rainfall, until July, when the crop was destroyed by locusts. Of the two, both on this plot and in private trial, the Sholapuri variety exhibited a somewhat stronger and quicker growth than the Nialo, though, in the circumstances, no comparison of real value could be made.

**Tanganyika.**—According to a report on the work of the Morogoro Experiment Station for 1928, variety trials with sorghum have been carried out at that station. The sorghums have been divided into three types, and the object of the experiment has been to find the most suitable varieties in each type. The types are : (1) Heavy yielding, with a hard grain suitable for storage or export ; (2) Heavy yielding, not necessarily suitable for storage or

export; this class includes soft-grained varieties; and (3) Early maturing. The experiment has been conducted on these lines for three successive seasons. The details of the 1928 season are given below, together with a summary of those of the preceding years. The obviously inferior varieties included in the 1926 and 1927 experiments have been discarded.

All varieties of heavy yielding types were planted on December 22, 1927. This is the normal sorghum planting season. All the varieties suffered very severely from the six weeks' drought after planting. In practical farming the crop would be regarded as a failure but the results are interesting as they give comparative yields under adverse conditions.

Variety.	Yield per acre in kilos.	Order of yield.
Bonganhilo . . .	55	III
Kilinyali <sup>1</sup> . . .	195	I
Ngwana Kwimba <sup>1</sup> . . .	85	II
Suksha <sup>1</sup> . . .	30	IV
Kihemba-hemba . . .	15	V
Karachi <sup>1</sup> . . .	15	VI

<sup>1</sup> *Hard-grained varieties.*

As the conditions of the first planting resulted in crop failure a second planting was carried out on February 16, 1928, just at the commencement of the heavy rains. The following table gives the results, together with the comparative yields of the varieties in this experiment over three years.

Variety.	Yield per acre in kilos.	Comparative yields.		
	1928.	1926.	1927.	1928.
Bonganhilo . . .	1,000	100	100	100
Kilinyali <sup>1</sup> . . .	840	80	62	84
Ngwana Kwimba <sup>1</sup> . . .	540	67	54	54
Suksha <sup>1</sup> . . .	430	87	52	43
Kihemba-hemba . . .	100	not grown	42	10
Karachi <sup>1</sup> . . .	70	19	I	7
6 other varieties . . .	Discarded in 1928	—	—	—

<sup>1</sup> *Hard-grained varieties.*

Thirteen varieties of early maturing types of dwarf sorghums imported from the Sudan and the United States of America were grown on the Station. Dwarf sorghums have been imported and tried on this Station since 1924 without success. The object of the importation has been to give an early source of food, if possible, growing the crop during the short rains. Every attempt to grow

these sorghums early in the season has resulted in failure. In seasons where the early rains have been scanty the sorghums have made such poor growth that the yields have been negligible; in seasons where the early rain has been adequate for growth, flowering and setting of seed has occurred at the opening of the heavy rains, with the result that the heads have not set or have been so damaged by fungus diseases that no crop has been harvested. This season it was decided to try planting these quick growing sorghums at different periods to see if economic yields could be obtained at any period. Three plantings were attempted, the first in the short rains (December 21), the second during the rains (February 20), and the third towards the end of the rains (April 5).

All the yields have been so low that any attempt at giving a table of comparative yields would be misleading. Yields have ranged from nil to a maximum of 110 kilograms per acre, and the grain harvested has not been perfectly sound. The futility of these yields is shown when compared to the yield obtained from the variety Bonganhilo—1,000 kilograms per acre.

In spacing experiments carried out at Morogoro three one-tenth-acre plots were planted with the variety Bonganhilo and three with the Kilinyali at each spacing, so that each series of the four different spacings was replicated six times. All plots were planted on February 16, 1928. The rows were all three feet apart, except in the native method, in which instance planting was not in rows. The results are given below:

Distance of planting.	Plot yield in kilos.						Average.	Order of yield.
	Var. Bonganhilo.			Var. Kilinyali.				
	1.	2.	3.	4.	5.	6.		
6 inches apart	116.0	115.5	129.5	72.5	72.5	51.0	92.8	II
12   "   "	110.5	110.5	115.5	83.5	65.0	43.0	88.0	III
18   "   "	121.5	116.5	83.5	87.3	58.0	15.0	93.3	I
Native   .   .	93.5	100.0	72.5	91.0	54.0	8.0	82.5	IV

In calculating the average yield the last two plots in series 6 have been omitted as these plots at the end of a range were severely damaged in a wind storm.

Planting in rows three feet apart with the spacing in the rows eighteen inches gives approximately the same number of plants per acre as the native planting method. Although the above results are not conclusive they indicate that the native has arrived at the optimum planting distance by experience, but that by planting haphazard

instead of in rows weeding is more difficult and lower yield results.

In a report on the work of the Mpanganya Agricultural Station, Rufiji, for the year ended March 31, 1929, it is stated that the indigenous sorghums, although hard-grained and consequently of good keeping qualities, require a period of 4 to 8 months to mature; they, moreover, grow to a height of 10 to 15 feet, are very exhaustive to the soil, and are subject to smut. Three introduced early maturing types, resistant to smut, were tried at the Station. One of them, Dwarf Hegari, had proved suitable in previous seasons, but the germination of this variety and also of Dwarf Yellow Milo was poor and no seed was harvested.

With Feterita sorghum, a new introduction from the Sudan, a sowing on January 13 yielded 65 lb. per acre, but the grain was mouldy and of poor quality. A second sowing on March 14 gave 155 lb. per acre, but although better than the first sowing, there were again many blind ears due to moulds and the quality of the grain was poor. A third sowing made on June 2 on a low-lying island in the river gave 360 lb. of grain of excellent quality and no moulds were observed. It was found that the large soft grain rapidly became weevil infested, and although Feterita should have good possibilities in drier areas, it is useless for introduction into the native agriculture of low coastal districts. This variety may have considerable value for hybridising with a local variety for the production of a type having early maturity, dwarfness and smut resistance, combined with hardness of grain. A criticism that is often heard against quick maturing types is that they are especially vulnerable to losses by birds and monkeys, but this is avoided by planting later than the longer maturing kinds when the harvests will coincide. Trials of local varieties were also carried out with the following results:

Variety.	Comparative yield.
Nokori . . . . .	94 (III)
Mbangara. . . . .	100 (I)
Jebesi . . . . .	21 (VI)
Kibwe . . . . .	86 (IV)
Kanga . . . . .	100 (I)
Hdunyungu . . . . .	43 (V)

#### FODDERS

**Somaliland.**—Mr. R. A. Farquharson, Director of Agriculture, reports that Sudan grass appears to be of con-

siderable potential value in Somaliland, certainly for native use and, probably also, when animals become accustomed to it, for Government use as well.

Fresh seed was imported from New South Wales, and sown in one plot. It was up and growing well by the middle of May, and showed an excellent and strong growth by the end of that month. Even in July, in spite of the prolonged lack of rain, it was still doing well ; but, as in the case of other crops, was in that month destroyed by locusts.

There is hardly any doubt that the general agricultural conditions in this country are suitable to it, and, to judge from experience in other countries, there is no reason why its cultivation should not be beneficial at least to the natives.

Other grasses which will be experimented with are Guinea grass, Kikuyu grass, and South African veldt grass, as well as some local varieties.

## FRUITS

**Somaliland.**—Mr. R. A. Farquharson, Director of Agriculture, has furnished the following report on work carried out on the orchard plot at Hargeisa.

All the mango seedlings continued to grow strongly until the middle of the severe drought which was experienced during the year, when the leaves became somewhat burnt. Of the three mango grafts, two died but the third continued to flourish.

Vine cuttings (from local vines) struck well, and, when planted out on a trellis, grew vigorously.

Passion fruit seedlings raised in boxes were transplanted in April, and, grown on a trellis, found the conditions so suitable that flowers and fruit appeared before the end of the year.

While on leave, the Director purchased in Australia on behalf of the Government the following : rooted vines of the most approved table grape varieties ; grafted Washington Navel seedless orange trees ; grafted apple trees of approved varieties ; and grafted peach, nectarine and apricot trees (two each).

These were all planted by the beginning of October, and, except for one apricot tree which was killed by white ants, grew strongly at once. If experimental growing of these trees proves successful, it is intended to replace to a great extent the vines now growing in native gardens with better eating varieties, and on the seedling stocks of

apples, limes and lemons to graft scions from approved introduced varieties.

Further, Cheromoya seeds and Kew Pineapple suckers were obtained from Ceylon. The former germinated very quickly and appeared to thrive under local conditions. The pineapple suckers, however, though shaded from the wind and sun, took a long time to strike and progressed very slowly. It is very doubtful whether their introduction will be a success in this climate.

Towards the end of the year, seedlings and seeds of grape fruit, Italian lemons, mandarins and limes were ordered from India and Australia. There is good reason to believe that citrus fruits, with proper care, will find the soil and climate of the hill stations congenial.

## LEGUMES

### *Gram*

**Somaliland.**—Mr. R. A. Farquharson, Director of Agriculture, reports that during 1928 seed gram from India was sown in one plot at Hargeisa in drills, though a small amount was broadcast for use as a soil improver in an extension of the main plot, roughly prepared for fallowing. The growth of both the drilled and the broadcast seed was excellent up to the middle of May, but, thereafter, the drought began so seriously to affect it that by the beginning of July only part of the crop was maturing. A sparse crop of good seed was, nevertheless, obtained before the arrival of locust swarms, and there is little doubt that, with a normal rainfall, a good crop in the main plot would have been assured.

**Tanganyika.**—According to a report on the work of the Morogoro Experiment Station for 1928, variety trials with the following crops were carried out. (1) Native green seed gram (*Phaseolus Mungo*); (2) Tepary beans; (3) Native kidney beans (*P. vulgaris*); (4) Black seeded gram (*P. radiatus*).

A first planting was made on October 28, 1927, but this attempt to grow quick-maturing legumes in the short rains was a complete failure. Germination with the early November rains was good. Then followed three weeks of dry weather. This completely killed the local kidney beans. The tepary beans and the two varieties of gram suffered severely, but to a less extent. At the end of November a few showers of rain fell, and seed was supplied to fill in the stands in each plot. It was not till December 15 that the short rains really commenced and for a

fortnight good rain fell, but it was too late to save the crop. The dry spell of January put the finishing touches to what was already a failure. On February 10, 1928, all ripe seed was harvested and the plots were hoed up for replanting.

A second planting, made on November 28, 1927, fared little better than the first. The dry weather in January checked growth and the yields recorded are practically nil.

A third attempt was made to obtain comparative yields, seed being planted on February 20, 1928. Germination was good and the crop made good growth until an epidemic of beetles (*Ootheca bennigensi*) appeared and the plants were defoliated. Dusting with calcium arsenate was carried out under the advice of the Entomologist. Owing to the continuous rain at this period the dust was washed from leaves and the poison had little effect in checking the insects. It was noted that the black-seeded variety of *P. radiatus* resisted the attacks of the beetle more than the other crops. This was probably due to its hirsute leaves. All crops suffered very severely and no yields were obtained.

A fourth and final planting was made on April 2, 1928. Germination was again good, but the beetles completely defoliated the plants. The only seed harvested was from the black-seeded gram, and this only in very small quantity, viz. 7 kilograms per acre.

At the Mpanganya Agricultural Station, Rufiji, trials have been made with introduced early maturing pulses.

*Sugar Beans* from South Africa were sown at monthly intervals from January to April, but the germination was very poor, and it was only with difficulty that any growth was obtained. The plants which survived the dry periods were sickly and, although they flowered, none produced seeding pods. It can be stated definitely that this crop is quite unsuited to coastal conditions.

The *Tepary Bean* held out good possibilities of drought resistance. The first two lots of seed did not germinate; a third lot from the February picking from the Morogoro Station was sown in March and yielded only 80 lb. per acre, as compared with 740 lb. in the case of green gram, 1,140 lb. with cowpeas and 160 lb. with Bonavist bean, all indigenous to the district. The seed of Tepary bean that was harvested was carefully stored and sown during the short rains in November and December; two resowings were made but there was no germination. It would

appear that the germination power cannot be retained by Tepary bean in the moist valley climate, and this should be further investigated, as if this fault can be overcome the crop should be of value to the native agriculture of the district.

## ROOT CROPS

### *Potatoes*

**Somaliland.**—Mr. R. A. Farquharson, Director of Agriculture, reports that while on leave His Excellency the Governor purchased from Messrs. Sutton, for experimental purposes, 12 cwt. of seed potatoes of the variety "Epicure." At the time of the arrival of the seed up-country, it had been considerably desiccated during transit through the tropics, and, as it had to be planted before the Director proceeded on leave, it was of necessity put into a dry seed bed, a day or two before the advent of the rains, at the end of April. About 3 cwt. were planted at Sheikh and about 9 cwt. in the Orchard Plot of Hargeisa. From the 3 cwt. at Sheikh, 286 lb. of potatoes were obtained, whilst the 9 cwt. planted at Hargeisa is stated to have yielded only 180 lb. Undoubtedly, the crop in both places was badly affected by the drought, and it is certain that, with a better rainfall, a large crop would have been got. As in Hargeisa, however, the crop was all dug up by June, it appears to have been dug up too soon. In Kenya, for example, according to the Annual Report for 1927, during potato-growing trials, after the stems had attained a height of 12 inches, the rains ceased, and dry conditions prevailed until after the harvest. In spite of the abnormally dry environment, when the soil hardened like brick, and forking was almost impossible, returns of 5, 6 and 7 tons per acre were obtained after a period of growth ranging from 99 to 119 days.

Though the experiment last year must be regarded as a failure, the conditions attendant on the planting and growth of the crop must be regarded as exceptional, and, therefore, the results cannot be taken as a true indication of the prospect of growing potatoes with reasonable success. Moreover, as experiments in Kenya and elsewhere in the tropics have shown, not all varieties of potatoes are equally successful in unusual conditions, and trials of several different varieties are necessary, so as to determine which of them can be grown profitably and give the best yield.

## OILS AND OIL SEEDS

*Chaulmoogra Oil*

**Ceylon.**—*The Annual Report of the Department of Agriculture for 1928* contains the following references to experiments on plants yielding chaulmoogra oil.

The Curator, Royal Botanic Gardens, Peradeniya, reports that the raising of stocks of chaulmoogra oil plants for experiment and supply has developed considerably since his last report and plants of six different species are in stock for the purpose. Of the seeds of *Hydnocarpus Wightiana* received at the end of 1927 from Calcutta 400 are in stock in bamboo pots. The small consignment of *H. Woodii* received from Sandakan mostly failed to germinate, but 10 plants were successfully established in bamboo pots. These are being utilised as the stock plants on which to graft *H. anthelmintica* and *H. Wightiana* with a view to inducing an earlier fruiting of these species. Other seed of *H. Wightiana* was received in June, 1928, from Calcutta, and of this consignment 200 plants are in bamboo pots and a few remain in beds. Seed of *Taraktogenos Kurzii* received from the Conservator of Forests, Rangoon, in September, 1927, germinated quickly, and 700 seedlings have been established in bamboo pots whilst 450 remain in beds.

Seed of the garden chaulmoogra trees were collected and 120 plants of *Hydnocarpus anthelmintica* raised and potted, whilst 250 seedlings of *H. venenata* and 300 seedlings of *H. heterophylla* have also been established in bamboo pots for use as stock plants to *H. anthelmintica* and *H. Wightiana*. Experience to date on the use of these stocks on the *H. anthelmintica* tree in Section F show the progress to be very slow, the graftings made in June last not having successfully united at end of year.

The Assistant Curator, Heneratgoda Gardens, reports that fifty healthy seedlings of *Hydnocarpus anthelmintica* were set out in well-prepared holes in the lower part of the *Taraktogenos* plot. A good many plants of *H. Wightiana* were considerably damaged by a leaf-eating caterpillar (*Cirrochroa* sp.?) and the red borer (*Zeuzera coffeæ*). The pests were effectively kept under control by hand picking and subsequently by sprayings of superarsenate of lead. Of the two species of chaulmoogra plants, viz. *Taraktogenos Kurzii* planted in September 1926, and *Hydnocarpus Wightiana* planted in June 1927, the latter appears to be more vigorous in growth and has made more headway than the former. The average height of *Taraktogenos Kurzii* is three feet, the largest

being eight feet. The average height of *Hydnocarpus Wightiana* is five feet, the largest being eight feet.

### *Ground-nuts*

**British Guiana.**—According to the *Administration Report of the Director of Agriculture*, 1928, at the conclusion of the experiments on ground-nuts which had been initiated by Sir C. H. Rodwell at Cecilia Sub-station, results from which were given in the *Agricultural Journal* for June, 1928, experiments with this crop were continued, and included, in addition to the better known sorts of the confectionery type such as Virginia Bunch and Virginia Runner, certain oil-yielding varieties obtained through Mr. Sampson of Kew. It is too soon to say what the value of these new introductions will be. In the meantime, for supplying the local trade, Virginia Bunch is undoubtedly the variety best suited to local conditions.

**Somaliland.**—Mr. R. A. Farquharson, Director of Agriculture, reports that during the 1928 season, two samples of ground-nuts were planted, one from the Gambia, the other from Kenya Colony. By the middle of May, and as a result of the good rains at the end of April, both samples were well up, and showed a good level crop. Owing to the subsequent poor rainfall, the growth was checked, but, even in July, the two crops were holding their own, in spite of continued drought. The vitality of both samples was, indeed, rather remarkable, for, though the crops in the main plot were, for reasons given below, dug up in July long before maturity, a catch crop, grown primarily for green manure in the Orchard Plot, continued to maintain itself well into November, and where—as near wells—more moisture was available than elsewhere, it grew luxuriantly and provided sufficient nuts of excellent quality to serve for further trials next year. There appeared to be little difference in the progress of the two samples.

In July the crops on the main plot were destroyed by locusts, and, as the nuts attracted large numbers of ground squirrels, which could not be kept out by the crude thorn tree zeribas, they were dug up.

### *Sesame*

**Somaliland.**—Mr. R. A. Farquharson, Director of Agriculture, reports that during 1928 sesame (sim-sim) seed from the Kavirondo Province of Kenya was sown broadcast in one plot at Hargeisa. Though the seed germinated

well, the crop, owing, probably, to the drought, was a failure, except in one small patch. A previous trial sowing on a private plot of rather poor soil gave better results, but it was found that the green seed pods were attacked by a boring caterpillar and the inflorescences of even the strongest plants showed signs of fungoid disease. Trials, however, in native gardens, where the seed was sown amongst sorghum, resulted in vigorous plants, unaffected by either caterpillars or disease, but the amount of seed planted was very small. In the circumstances, further experiments with this crop will, for the present, be discontinued.

### ESSENTIAL OILS

**Cyprus.**—The report of the Director of Agriculture for the half-year ended June 30, 1928, states that the results of the distillation of two samples of Lavender leaves and flowers produced in the Nursery Garden, Nicosia, were as follows :

Sample No. 1. *Lavandula vera*. Imported many years ago.

Amount distilled . . . . .	19 lb.
Amount of oil obtained . . . . .	160 c.c.
Percentage of oil . . . . .	1·86 per cent.

Sample No. 2. *Lavandula vera*. Imported recently.

Amount distilled . . . . .	6 lb. 8 oz.
Amount of oil obtained . . . . .	11 c.c.
Percentage of oil . . . . .	0·37 per cent.

The low yield of oil is attributed to the fact that the plants contained too large an amount of wood in proportion to leaves and flowers.

Further trials are being made with *Lavandula vera* grown at Pedoulas in order to compare the oil distilled from plants grown on the hills with that from plants grown on the plains.

The Principal Forest Officer reports the following results of distillation of essential oils carried out by his Department during the half-year ended June 30, 1929.

Material.	Quantity distilled.	Yield.		Time of distillation.	Cost of production.
		lb.	oz. per cent.		per lb.
<i>Eucalyptus tereticornis</i> (fresh leaves) . . . . .	70	3·3	0·29	3½	£2 10s. 1d.
<i>E. tereticornis</i> (fresh flower clusters) . . . . .	5·6	0·48	0·53	1½	£5 3s. 11d.
<i>Pinus halepensis</i> (fresh needles) . . . . .	33·6	2·6	0·48	2¾	£3 4s. 7d.
<i>Myrtus communis</i> (fresh leaves) . . . . .	33·8	6·0	1·1	3	16s. 0d.

## FIBRES

*Cotton*

**Tanganyika.**—The following statement relating to cotton experiments at Morogoro are contained in the Report on that Experiment Station for 1928.

In a *Time of Sowing Experiment* two ten-acre plots were planted at intervals of one week from February 9 to March 22. A summary of yields, together with the weekly rainfall for the period prior to planting, is given below :

Date of planting.	Average plot yield in kilos.	Acre yield in kilos.	Comparative yield.	Rainfall in millimetres.
9.2.28 . . .	40.2	402	99	nil
16.2.28 . . .	40.5	405	100	8.9
23.2.28 . . .	35.9	359	88	35.7
2.3.28 . . .	24.0	240	59	26.5
8.3.28 . . .	19.2	192	47	29.1
15.3.28 . . .	3.0	30	7	10.3
22.3.28 . . .	15.4	154	37	nil
31.3.28 . . .	no planting	—	—	23.5

Below is given a summary of this experiment in previous years :

Date of planting.		Rainfall during month in mms.						Comparative yield.				
		Month.	1924.	1925.	1926.	1927.	1928.	1924.	1925.	1926.	1927.	1928.
February	1 .	—	—	—	—	—	—	—	—	67	—	
„	9 .	Feb.	261	118	46	4	57	100	100	—	99	
„	16 .	—	—	—	—	—	—	—	—	83	100	
„	23 .	—	—	—	—	—	82	85	83	80	88	
March	3 .	March	153	43	196	187	77	—	—	94	79	
„	8 .	—	—	—	—	—	—	26	62	100	47	
„	15 .	—	—	—	—	—	—	—	—	91	7	
„	22 .	—	—	—	—	—	—	9	0	86	85	
„	30 .	April	207	61	181	191	215	—	—	83	—	
April	6 .	May	77	41	62	44	128	—	—	60	17	

The above experiments demonstrate the soundness of planting as soon as the rains commence. In each year the highest yields are given by the earliest planting after the rains have begun, and in cases where rain is unduly late it appears sound to dry-plant in the latter half of February.

In the *Spacing Experiments*, as in the preceding years, all the plots were sown on the same day in rows 3 ft. apart, the distances between the plants varying

from 6 in. by intervals of 3 in. and 6 in. up to 30 in. The following results were obtained this season :

Distance of planting.	Number of plants to a hill.	Acre yields in kgs. seed-cotton.	Comparative yields.
3' × 6" . . .	1	405	100
3' × 9" . . .	1	392	96
3' × 12" . . .	1	313	77
3' × 18" . . .	2	335	82
3' × 24" . . .	2	347	85
3' × 30" . . .	2	256	63

An analysis of the results obtained in this experiment over a number of years is given below :

Distance of planting.	Comparative yields.					
	1923.	1924.	1925.	1926.	1927.	1928.
6 inches apart . . .	—	—	—	100	100	100
9 " " . . .	100	100	44	—	100	96
12 " " . . .	—	—	81	93	94	77
15 " " . . .	91	75	73	—	—	—
18 " " . . .	78	70	100	75	99	82
24 " " . . .	75	43	—	85	68	85
30 " " . . .	—	—	—	84	64	63

In forming conclusions from the above table the following points should be noted :

(a) In 1923, 1924 and 1925 the plants were thinned out to only one plant per hill.

(b) In 1926, 1927 and 1928 the plants were thinned out to one plant per hill in the 6, 9 and 12 in. spacings, but two plants were left in the 18, 24 and 30 in. spacings.

(c) 1925 was an abnormally dry season, which accounts for the wider spacing giving higher comparative yields.

(d) The number of plants per acre at each given planting distance is :

Distance of plants.	1 plant per hill.	2 plants per hill.
6 inches . . .	29,040	—
9 " . . .	19,360	—
12 " . . .	14,520	—
15 " . . .	11,616	—
18 " . . .	9,680	19,360
24 " . . .	7,260	14,520
30 " . . .	5,808	11,616

These results appear to lead to the conclusion that there is little practical difference in yield with single planting at 6 and 9 in. or double planting at 18 in., but that the difference is in favour of single planting at the closer spacing. Going a step further, it might be inferred that the highest yield is obtained when there are 19,360 to 29,040 plants per acre; and that with spacings giving less than 19,000 plants per acre yield in a normal season declines in direct proportion to the number of plants per acre. It has not been demonstrated that more than 29,040 plants per acre will give a lower yield. In 1923 to 1925 9 in. was the closest spacing, and owing to the results obtained a 6 in. spacing was included in the experiment in subsequent years.

From theoretical considerations it is sound to assume that the more evenly a given number of plants are distributed over a given area the better chance of development has the individual plant. Thus a spacing with single plants per hill is theoretically better than a spacing with two plants to a hill where both spacings give the same number of plants per acre. This is demonstrated in the above results.

Practical considerations, such as weeding, cultivating and harvesting, make it undesirable that the rows should be closer than 2 ft. apart. The problem now resolves itself into a simple calculation as to what spacing in rows 2 ft. apart will give 29,040 plants per acre. This works out at 9 in. apart. Thus combining theory with the field observations above, it would appear that spacing rows 2 ft. apart and single plants left 9 in. apart in the rows would give the best results.

The above remarks are not conclusive as the evidence is insufficient. The experiment is being continued to refute or corroborate the suggestions put forward. It should further be noted that any quantitative conclusions drawn from this experiment would apply only to cotton grown under conditions of soil and climate similar to those on this Station.

Only seven varieties were included in the *Cotton Variety Trials* carried out at Morogoro in 1928. Of the fourteen varieties tried in 1927 the following were discarded as having proved unsuited to local conditions, Griffin, Improved Bancroft, R.M. 53, Watts Long Staple, R.M. 90, Webber 49 and King. The seven varieties remaining in the experiment were sown on February 23, 1928, all varieties receiving identical treatment throughout the season. A summary of the results obtained with these varieties is given in the following table.

Variety.	Yield per acre in lb. of seed- cotton, 1928.	Comparative yield.			
		1925.	1926.	1927.	1928.
Local (Uganda origin) .	592	100	100	100	100
M-Selection . . .	400	—	—	75	67
Foster x Whitehall . .	581	—	—	74	97
R.M. 68 . . .	517	—	78	61	87
N.17 . . .	499	—	—	44	84
Rustenburg O. . .	473	—	—	40	79
Over-the-top . . .	521	128	75	88	88

In all cases the seed used was produced on the Station in 1927 in isolation plots. It will be noted that in the cases of the varieties, Foster x Whitehall, R.M. 68, N.17 and Rustenburg O., this seed has given a higher comparative yield than that obtained in 1927 with the imported seed. The local strain of Uganda continues to give the highest yields, and no variety has shown such outstanding merit that multiplication of seed with a view to general distribution would be justifiable. The product of price and yield is the ultimate index of the value of a variety. The Liverpool broker's valuations of the samples of seed-cotton sent for examination to the Imperial Institute in 1927 indicate that the varieties R.M. 68 and Foster x Whitehall are the only two varieties in the experiment which appear at all likely to challenge the premier position of the local cotton.

At the Mpanganya Agricultural Station, the *Time of Sowing Experiment* was carried out in duplicated 1/40 acre plots in both Section A, representing the light unflooded higher lands of the Rufiji valley, and Section B, representing the loams and black cotton soils of the valley lowlands which are liable to flooding. The following results were obtained :

Plot No.	Time of sowing.	Monthly rainfall, mm.	Section A.		Section B.	
			Percentage stand.	Comparative yield.	Percentage stand.	Comparative yield.
1	9.1.29	January 53.1	76	100 (I)	39	84 (IV)
2	23.1.29	February 51.9	24	44 (IV)	17	46 (IX)
3	6.2.29	March 116.8	35	62 (III)	34	73 (VII)
4	20.2.29	April 162.6	66	75 (II)	29	78 (V)
5	5.3.29	May 67.3	97	37 (V)	98	71 (VIII)
6	19.3.29	June 13.0	91	31 (VII)	79	77 (VI)
7	2.4.29	July nil	89	34 (VI)	98	100 (I)
8	16.4.29	August 12.4	70	25 (VIII)	90	93 (II)
9	1.5.29	September 26.9	71	22 (IX)	90	88 (III)
10	15.5.29	October 2.6	nil	nil	nil	nil

Comparison with previous years is shown in the following table :

Year.	Optimum date of sowing.		Yield of seed-cotton per acre.	
	Section A.	Section B.	Section A.	Section B.
			lb.	lb.
1922 . .	March 5	—	—	—
1923 . .	March 1	—	—	—
1924 . .	March 24	—	—	—
1925 . .	March 3	—	1,136	—
1926 . .	February 5	January 8	812	1,420
1927 . .	January 22	January 22	692	1,050
1928 . .	January 9	April 2	422	360

Past experimentation has shown that the critical time in the life of the cotton plant is during the week following germination whether this takes place immediately after sowing or is delayed for some weeks. Given favourable rains to establish the young seedlings, the young plants quickly reach a stage of resistance to rainless periods and recovery after such periods is rapid when rain does fall, so that if sown early the crop is flowering before the end of the rains and maximum yield is assured by the heavy first picking of good quality cotton which results. Early sowing is of special importance with the light soils of Section A, and in the series of this section the plots sown on January 9 and February 20 alone received favourable rains over the critical periods. Plots 2 and 5 suffered badly in this respect, as will be seen from the low percentage stands ; the figures of percentage stand, that is the percentage of plants which mature, are a measure of the amount of increase which would be forthcoming by resowing, as would be made under commercial conditions of production. For example the early sown plot No. 2 shows a percentage stand of 24, and it is obvious that the yield could be trebled by resowings, whereas with plot No. 5 the stand is 97 per cent. and the yield even lower than with plot No. 2, and it is equally apparent that little if any increase could be expected from resowing. This all accentuates the importance of sowing early whether there is rain or not ; if this is done, resowing can be made and maximum yields obtained, whereas delay may result in losing the benefit of the early rains even though these be scanty. The optimum time of sowing depending so much on rainfall distribution as well as amount, no date can be prescribed as the optimum time for sowing, but the season's work has not only confirmed previous experimentation but has enabled a more narrow period to be

given for optimum sowing, namely from the last week in January to the end of February; cotton sown earlier in January may yield more heavily, as in plot No. 1, Section A, of the above series, but the quality is poor. With the plots sown from March 5 onwards, the rains over the critical period were favourable, but the later rains were not sufficient for profuse boll production.

With the corresponding plots of the lowland soils of Section B, the results as in the 1926 season reflect the character of the soil. In that season a very heavy down-pour caused early waterlogging of soil which promoted denitrification over the growing period and this negated any differences which might have occurred from sowing at different intervals. To a less extent the observable differences in yield in 1928 are again hidden under the levelling influence of lack of rain, the comparative differences in yield being much less than with Section A. The silt soil of Section B has great water absorptive power, and heavy rain is necessary to bring such soil to the point where soil water is freely available for plant growth, and also to produce a texture when the soil cracks are filled by expansion of the soil particles. Also such soils retain moisture to a greater degree than occurs in the light soils of Section A, and hence the optimum period of sowing of cotton extends two months longer than with Section A. Comparing plots Nos. 9 and 10 of Section B, it will be seen that the yield drops from 88 per cent. to nothing, although there is only a fortnight between the sowings; this again proves the rule, which is all too often ignored by cotton growers, not to wait for rain to sow but to be prepared for it with cotton seed in the ground.

The low yield per acre as compared with previous years indicates the poor season for cotton general throughout the district; the unusually heavy rains in August and September were also harmful to the quality of the cotton harvested.

In the *Spacing Experiments* with cotton at Mpanganya, a series of six plots at different spacings were sown in duplicate 1/40 acre plots in both Sections A and B. The results are given in the following table:

Plot No.	Spacing.	Comparative yield. Section A.	Comparative yield. Section B.
1 . . . . .	3' × 6"	100	94
2 . . . . .	3' × 9"	92	97
3 . . . . .	3' × 12"	80	92
4 . . . . .	3' × 18"	94	100
5 . . . . .	3' × 24"	90	97
6 . . . . .	3' × 30"	82	84

It will be seen that no significance can be attached to the differences in yields of the above plots, except that taken as a whole there is evidence that the closer spacings give the best results, especially in Section A, the conditions of rainfall being so adverse that the plants are reduced to a struggle for existence which overshadows any differences in yield between plots of different treatments.

In the *Variety Trials* at Mpanganya, seed of thirteen varieties and eight Mp selections were sown in triple consecutive lines, with ordinary district cotton as a control, to obtain comparative results per 100 plants, but owing to the failure of the rains and despite two resowings a very poor and uneven germination was obtained, which, combined with later damage by elephants, rendered the results of no value. Seed maintenance plots were also sown in both sections, but these had no comparative value. One acre of J cotton was sown for further possible mass multiplication.

*Ratooning Experiments* were also conducted at Mpanganya, the experimental cotton plots of 1927 being ratooned at the end of that season instead of being uprooted and burnt in the usual manner. The ratooned plots gave an aggregate yield of but 10 lb. per acre. The results are correlated with previous years in the following table :

Year.	Yields per acre of seed-cotton.	
	Ratooned cotton.	Ordinary cotton.
	lb.	lb.
1926 . . . .	433	733
1927 . . . .	29	485
1928 . . . .	10	183

The above results definitely rule out the ratooning of cotton as an economic proposition even to the farmer who may be out for quantity irrespective of quality. Moreover, the method is not as cheap as first appears, it being necessary thoroughly to clean the land two or three times over the period from the end of the short rains to the early long rains. There is also the entomological view-point: in 1927 the incidence of insect pests with ratooned as compared with ordinary cotton was in the proportion of 4 : 1 for cotton stainers, and  $1\frac{1}{2}$  : 1 for boll worm, while the equivalent figures for 1926 were 3 : 1 and 2 : 1 respectively. As regards the quality of lint, samples of ratooned and ordinary district cotton of the 1927 season were sent to the Imperial Institute for

examination, the average length of fibre of the ordinary district cotton being 1·2 in. as compared to 1·12 in. of the ratooned cotton; the strength and lustre of the ratooned cotton were also inferior to the ordinary cotton. The commercial valuation by brokers in Liverpool priced the ordinary cotton at 12·80 pence and the ratooned cotton at 9·80 pence per lb. with "middling" American at 9·80 pence per lb.

Earlier experimentation at Mpanganya, in 1923 and 1924, showed that an unusually deep preliminary digging gave no increase in yield over plots dug in a shallow manner, and last season this work was carried further. Plots were dug in the usual manner, while with a second series the tall grass and weed growth was merely cut down at the root immediately below the tufts from which tillering occurs. The grass was then raked into rows 3 ft. apart, cotton being sown between these rows at the usual spacing of 3 ft. by 18 in. and at the same time the control dug plots were sown. At the time of thinning a deep cultivation was given without disturbing the rotting grass between the rows of cotton which served as an effective mulch and subdued weed growth; the benefits of this neutralised any advantage which may have been given by the preliminary digging, and there was no significant difference in yield between the two series, while the cotton sown on the carefully dug plots cost some twelve shillings per acre more than with the extensive method, and to the cotton planter the benefit will be greater in that he can get a greater acreage sown during the optimum period than where intensive cultivation is first followed. A rule to be observed in following the above method is to cultivate and clean the land well after all sowings have been made.

## RUBBER

### *Hevea*

**Ceylon.**—According to the *Annual Report of the Department of Agriculture for 1928*, the results of the old manurial experiments in rubber carried out at Peradeniya were published in *The Tropical Agriculturist* of July 1928, but they should be studied in conjunction with the comments made by the Economic Botanist in *The Tropical Agriculturist* for November 1928. There is no doubt that nitrogen gives a significant increase of yield. Other experiments in progress are a one-third resting experiment, a change-over tapping experiment, a comparison of yields

of alternate-day and three-day tapping, and a comparison of yields of alternate-day tapping throughout the year with the yields of two series of daily tappings in alternate months. The brown bast experiment of the Physiological Botanist of the Rubber Research Scheme which attempted to show whether the incidence of brown bast was governed by the cutting of the bark or by the withdrawal of latex gave inconclusive results.

The Iriyagama Division has been opened for the testing of clones of budded rubber. Ten acres were contour-terraced, planted with *Centrosema pubescens* as a cover, and supplied with four plants per hole, while the clearing and planting of a further forty acres were undertaken towards the end of the year. Seedling and budwood nurseries were laid down. It was hoped to bud part of the planted area in 1929, but it has been found necessary to postpone the budding until 1930. The money expended on the Iriyagama Division is provided from the Rubber Restriction Fund. Steps were taken towards the acquirement of land at Paspolakande, an area which will also be devoted to the testing of clones of budded rubber.

### *Jelutong*

**Federated Malay States.**—According to the *Report on Forest Administration* for the year 1928, an advance copy of which has been furnished to the Imperial Institute, Mr. D. C. V. Georgi, Acting Agricultural Chemist, maintained close touch with the local representatives of the American chewing-gum manufacturers, and was in communication with their chemists regarding the keeping properties and water content of jelutong shipped from Malaya. It now appears that one of the most fruitful causes of deterioration is the presence of minute quantities of iron in the latex prior to or during coagulation. Steps are being taken to impress on the collectors the necessity for the utmost care in this respect, for the merest trace of this substance is sufficient to cause resinification and thus render an outwardly satisfactory consignment entirely useless during the voyage to America.

The question of water content is of great importance, for payment to licensees is based on an average of 45 per cent., deductions or additions being made according as the content is above or below this standard. An exhaustive series of tests has been carried out by Mr. Georgi, who has definitely shown that the distribution of water, not only within a consignment, but within a single brick of jelutong, is so irregular that the old haphazard

sampling methods are not compatible with the meticulously accurate calculations of value that are based on them.

A practical simple solution of both these problems has still to be devised, but it seems likely that one of the chief results of Mr. Georgi's researches will be that the purchasers will allow wider limits with regard to moisture and attach considerably more importance to cleanliness in collection and coagulation. A standard procedure is being worked out on these lines.

The trees in the Weld Hill Forest Reserve continue to be tapped by the same method as in the previous year, all cuts now occupying occluded surfaces without any sign of damage to the tree. There have been no further casualties from insect or fungus attack in spite of complete discontinuance of the use of preservatives or disinfectants of any kind.

## FORESTRY

### GENERAL

**Somaliland.**—Mr. R. A. Farquharson, Director of Agriculture, reports that in the tree nursery at Hargeisa, which has necessarily included seed boxes in the private bungalow of the Director, success was met with in growing *Melia Azedarach*, *Schinus molle*, *Eucalyptus ficifolia*, *E. cladocalyx* (sugar gum), *Bauhinia purpurea* and *B. variegata*. These trees are now growing in private gardens and, particularly *Melia Azedarach* and *Schinus molle*, in the native township of Hargeisa.

Through the courtesy of the Forestry Department of Western Australia, seedlings and seeds were obtained of several species of Acacia and Eucalyptus, of *Sterculia Gregorii* (Kurrajong), of *Agonis flexuosa*, *Robinia Pseudo-acacia*, *Grevillea robusta* and *Hakea laurina*; and those of the seedlings which survived the long ocean voyage were at once planted out. Some of all the genera are growing well under shade. Seeds were also obtained of *Ceratonia siliqua* (Carob bean) and *Pinus Pinaster* and *P. Halepensis*.

Of the two species of pine, viz., *P. Pinaster* and *P. Halepensis*, the latter, which prefers a lime soil, will probably prove to be more suitable to the country than the former, which prefers a siliceous sandy soil and does not thrive where lime is present in quantities of over 0.4 per cent. As it has been proved that pines establish themselves with difficulty in soil that does not contain the necessary bacteria, a small amount of inoculated soil was brought from Australia, so that the seedlings could be planted in it and on final transplanting could by

means of a small ball of earth inoculate the surrounding soil.

Through the courtesy of the Director of Agriculture of Ceylon, seeds were obtained of *Albizia Lebbek*, *Leucæna glauca*, species of *Gliricidia*, some species of *Acacia*, and species of *Casuarina*, all of which were thought to have a chance of becoming established. *Leucæna glauca* has already become established at Port Sudan, though not at the same altitude as Hargeisa.

## TIMBERS

### *Products*

**Cyprus.**—The Principal Forest Officer reports that experiments were made during the half-year ended June 30, 1929, to endeavour to utilise charcoal dust by manufacturing it into brickettes, using pitch as the binding material.

The first three experiments were carried out with 2 per cent., 5 per cent. and 10 per cent. of pitch mixed with the charcoal dust. The respective costs were £2 7s. 2d., £3 12s. 8d. and £5 17s. 3d. per ton. All of these experiments, however, were found to be unsatisfactory since the brickettes crumbled easily and could not have stood transport.

Later, further experiments were carried out with similar brickettes, i.e. using 2 per cent., 5 per cent. and 10 per cent. of pitch. On being taken from the press they were dipped in boiling pitch. This raised the proportion of pitch to 5 per cent., 8 per cent. and 13 per cent., and increased the cost of production to £3 17s. 5d., £5 3s. 2d. and £7 7s. 6d. per ton respectively. After dipping in pitch the brickettes were found to be quite satisfactory, but the cost is prohibitive with the existing apparatus.

**Federated Malay States.**—The *Report on Forest Administration* for the year 1928, an advance copy of which has been furnished to the Imperial Institute, contains the following reference to the distillation of mangrove wood.

Mr. R. O. Bishop visited a number of mangrove charcoal kilns in Negri Sembilan and considered the possibility of collecting some of the volatile by-products by methods that would be within the means of the Chinese proprietors, and that would not affect the output of charcoal. The work was continued by Dr. Buckley, who subjected samples of *Rhizophora conjugata* L. and *R. mucronata* Lam. to distillation in a closed retort heated by a furnace, and proved that both of them were capable of yielding the usual by-products in normal amounts.

Though the Chinese kilns are, in some respects, peculiarly suitable for the collection of volatile substances (being provided with permanent vents for the escape of gases), their position in the swamps makes it difficult to obtain a regular supply of condenser water without resorting to pumps and storage tanks that would increase the overhead charges to a figure far beyond the means of the proprietors.

### GUMS

**Somaliland.**—Mr. R. A. Farquharson, Director of Agriculture, has furnished the following report made by Messrs. Rowntree and Company, Ltd., on 8 cwts. of Somaliland gum (as exported) supplied to that firm.

"With reference to your letter of the 11th April, we have pleasure in giving you our report on the sample of Somaliland gum you were instrumental in obtaining for us. This gum is not very suitable for confectionery purposes; its gelatinous nature prevents proper purification.

"About 70 per cent. appears to be similar to the Kordofan gum, although it is not equal to it in quality. If it is actually the product of the *Acacia Vereke*, then we should imagine the tree is not growing in good climatic conditions for the production of gum. The remaining 30 per cent. is of a very mixed type, and it is this part, in particular, that is wholly unsatisfactory. We have no doubt that a better product could be obtained by more careful collection, particularly by organised tapping of the trees.

"In the sample we handled there was strong odour and taste of incense gum. We could not trace any actual incense gum in the consignment, and imagine this was, probably, caused by the fact that the gum had been stored near some incense gum at some stage. We do not know to what extent the organisation of the collection could be carried. The proportion of suitable gum<sup>1</sup> is very high, and it may possibly be a comparatively simple matter to get across the natives what should be omitted.

"The Sudan Government have given very great and careful attention to the problem of cultivation, collection, tapping and renovation of forests, and make a very considerable revenue from the gum trade. The Nigerian Government has recently sent its Forest Officer to the Sudan for the express purpose of studying their methods,

<sup>1</sup> Note by Director of Agriculture: The apparent contradiction may probably be explained by the fact that in the first paragraph the sample was regarded as a whole, i.e. including the 30 per cent. of inferior value.

with a view to developing the gum possibilities of Nigeria. We, ourselves, are very anxious that any development or extension of the world's gum supplies should be within the Empire, and we should be glad, as a commercial firm, with considerable experience in the use of gum for edible purposes, to assist you in any possible way, should you decide to encourage the development of the gum resources in your Protectorate.

"As a matter of interest only, we noted in the course of our examination that gold was visible in the insoluble residue. We have had an assay taken and the amount certainly worked out very small, being 0.04 oz. per ton of 2,240 lb. This small amount of 19.2 grains to the ton would not, of course, pay for treatment, but it certainly denotes that there is gold, possibly in quantity, somewhere on the route along which the gum had travelled, and we thought you might be interested in knowing this."

Towards the end of the year, as a result of the determination of gold in the gum residue, mentioned in the last paragraph of the report, the Director geologically examined and prospected for some weeks the area from which the gum was obtained, and, aware of the lack of knowledge in the Protectorate concerning all aspects of the gum industry except licences and export, he took the opportunity, while on the spot, to ascertain the facts available. The information sought and obtained had reference to: I, the trees from which the gum was obtained, and the class of country and soil on which they grow; and II, the occurrence of the gum itself, the method of collection and the existence or absence of any method of tapping the trees. The results obtained in this survey are given below.

I. It was soon found that the Acacia gum exported was obtained from two kinds of trees, called by the Somalis "Adad" and "Jalefan." Other Acacia gums are also collected, e.g. Hobloho and Niyal, but these are kept separate from the two former and are of much less value. Further, it was at once evident that Adad and Jalefan, though both of them Acacias, are of different species and easily distinguished from one another. Numerous enquiries, however, established the fact that, in spite of the differences between the two kinds of trees, and, to some extent, between the two kinds of gum, the product of both trees was invariably mixed together during collection, though more Adad gum than Jalefan gum was always collected, owing to the trees being in much greater numbers.

Though gums of various sorts have been exported

from Somaliland for hundreds of years, and though a fair proportion of the revenue has long been derived from them, beyond the fact that the trees are *Acacias*, nothing is known of them. From the industrial standpoint, the most important gum on the European market is, at present, *Acacia Vereh*. The demand for it is increasing year by year, and in countries in which the tree is known to occur in numbers, e.g. the Sudan and Senegal, great effort has been made for many years to foster its cultivation, and to improve its quality as a marketable commodity. In this Protectorate, licences are issued to natives for gum collecting and an export duty is charged on the gum, but it is not even yet known whether the material collected contains either in greater or smaller part the particular *Acacia Vereh*.

Opportunity was taken by the writer, while in the gum country behind Hais and Mait, to compare the trees with published descriptions of *Acacia Vereh* from the Sudan. It was found that the habit of the Adad tree, the character of the leaves, stems and thorns and of the seed-pods bore strong resemblances to the notable Sudan species, and from these resemblances, especially in the light of the statements of Messrs. Rowntree and Co., Ltd., that 70 per cent. of the material appeared to be similar to Kordofan gum, though it was not equal to it in quality, and that the remaining 30 per cent. was of a very mixed type and wholly unsatisfactory, there is reason to believe that Adad is *Acacia Vereh*. In view, however, of the occurrence of large numbers of the trees in the Protectorate, and of the present and future importance of the gum, and because of the fact that in any organised scheme of improvement of the gum industry in the country, exact knowledge of the trees is necessary, the identity of both Adad and Jalefan should at once be established.

In the area behind Hais and Mait, the class of country in which both Adad and Jalefan grow, is a series of vertically inclined, more or less metamorphosed sedimentary slates, which form a large number of serrated ridges at the bottom of the main escarpment. Adad, particularly, grows in such profusion on these ridges that it is very difficult to traverse them, on account of the hooked spines. Both trees, however, also grow on flat spurs, composed of a mixture of slate and limestone debris, and also on the flats and banks of tugs, composed of an alluvium of the same character. Adad, however, is evidently not restricted to such soils. It occurs in numbers at Adad, about 100 miles south of Erigavo, where the whole country consists of Tertiary limestone, and grows in pro-

fusion in the vicinity of Gondo Libbah, just across the border south of Oadweina, where the soil is largely formed from limestone. It also occurs at Hargeisa on a Tertiary limestone soil, though no gum is there collected from it. In the Warsangeli and Mijertain country behind Gedweda, Las Khoreh, etc., Adad is also abundant, partly on a limestone soil and partly on a sedimentary slate soil. The determining factor in the successful growth of Adad—at any rate, where either a Tertiary limestone or slate soil is present—would appear to be altitude.

Just as in the ridges behind Hais and Mait and in the country behind Las Khoreh, so at Adad and Gondo Libbah, the altitudes at which Adad is found and profitable gum is produced range from 2,000 to 3,500 ft. (approximately). As moisture from rainfall and sea breezes is much greater in the foothills of the main escarpment than in the interior plateau or in the Haud, and as the gum is produced equally well in all three regions, proximity to the sea and rainfall are clearly of less significance than altitude.

II. The gum occurs as blebs or as a thick coating on the stem of the trees close to the ground. After a time, the blebs may fall off to the ground. The native collectors pull off the blebs and coatings from the stems, or pick up the fallen gum, careless whether bark or sand is still adhering. The pieces, whether of Adad or of Jalefan, are put into baskets or sacks and taken to the coast, though it must be said for the collectors that after the gum has been picked, it is not again allowed to touch the ground.

In the hills behind Hais and Mait, no method of tapping the trees is employed. The gum is allowed to exude naturally and is then pulled off, though, in some cases, a wound is formed on the bark through the force exerted in taking off the gum.

In the Warsangeli and Mijertain country, however, a rudimentary method of tapping is, in some instances, adopted, which takes the form of deliberately bruising the bark of the stem over a space of a few inches. Nevertheless, nowhere is any slitting of the bark practised, so that only very rarely does the gum come cleanly from the stem.

The collection of the material is made soon after the Kharif stops.

In view of what has been set out above, it would appear that the following steps should be taken as soon as possible :

1. The exact botanical identity of both Adad and Jalefan should be determined. With this end in view, the Director, while in the gum country behind Hais, made a collection of the stems, leaves and seed-pods of

both trees, but no flowers could be obtained as none of the trees was near the flowering stage. Arrangements were made, however, to have the flowers collected as soon as they appear, so that all the necessary parts of the trees might be sent to Kew for determination purposes.

2. A second parcel of gum should be collected, restricted, in this instance, entirely to Adad gum, and carefully selected or graded, so that only the cleanest material is included in the parcel. From the report of Messrs. Rowntree, it is probable that the 30 per cent. regarded as wholly unsatisfactory consisted largely of Jalefan gum, with an admixture of Hobloho. If Adad only is collected, and the sample is carefully selected, there is little doubt that Messrs. Rowntree, Ltd., would again be willing to test it under the same conditions as on the previous occasion.

Once the tree has been proved to be *Acacia Verek*, and the present quality and existing defects in the produce have been determined by manufacturers using the gum, the question of what measures are to be adopted for its improvement may be considered. These will include :

(i). The introduction of a proper method of tapping the trees. The method is simple and the writer was assured by a number of the natives periodically engaged in the collection, that some, at any rate, would adopt it, if it meant a better monetary return.

(ii). The introduction of a system of grading, and supervision over the export of the material.

(iii). An alteration in the method by which Somaliland gum is put on the market, after it leaves the Protectorate.

At present, the gum is bought from the producers on the coast ; it is then shipped across to Aden. On arrival there it is, according to London merchants who handle the material, mixed with gums from India and Arabia, and sold in London as "Aden" gum. It is, therefore, clear that if any improvements are in future effected in the gum industry of this country, in order to prevent their being nullified the product should either be bought directly in Aden, as Somaliland gum, by an agent of a London firm, or shipped direct to London from Somaliland.

## MINERAL RESOURCES

### FEDERATED MALAY STATES

The Imperial Institute has received from the Director of the Federated Malay States Geological Survey Department (Mr. J. B. Scrivenor) a report on the research work carried out by his department during the first six months

of 1929. From the report the following notes have been compiled.

The survey of Trengganu by Mr. H. E. Savage has been continued and it is expected to complete the work during the present year. An interesting collection of Triassic lamellibranchs obtained from Kelantan is considered to remove all doubt regarding the age of the sedimentary rocks which comprise Gunong Tahan, the highest mountain in the Malay Peninsula. Further work has also been done in regard to the mapping of Pahang and Negri Sembilan.

The Mining Geologist has continued his researches at Gunong Bakau and has obtained interesting information supplementing that collected by the Director in earlier years. There is no reason, so far, to modify the published results given by the latter officer. The Mining Geologist is preparing a paper on this very interesting occurrence of rocks, which contain topaz and tin-ore.

On Cameron's Highlands, road construction through an area of schists brought to light a mass of calc-silicate rocks and their junction with granite. As the apparent absence of limestone on the Highlands is a serious drawback to development, a search was instituted for any calcareous rock that could be used for making lime, but none was found, all the calcareous rocks having been impure before metamorphism occurred.

Further work on brick-making was carried out by the Chemist.

Joint work with the Agricultural Department was carried out on soils. This work will be extended. Malaya has the reputation of being extremely fertile, but the soils over most of the Peninsula are very poor and the work of mapping on a large scale the areas of good soil, such as those derived from dolerite in Kuantan, and from basic Pahang Volcanic Series soils, is urgent.

Tourmaline-corundum rock was found in contorted schists in a deep open-cast mine at Tanjong Toalang and was also cut by a kaolinised granitic rock in the same mine. In the schists the rock partly resembles a vein-rock, and partly forms small lenticular masses. It consists almost entirely of tourmaline, corundum, chalcedony and rutile, the first two being the main constituents.

## NIGERIA

The Imperial Institute has received from the Acting Director (Mr. C. Raeburn) of the Geological Survey of Nigeria, the following report on the geological research

work carried out by the Survey during the first six months of 1929.

*Gold.*—Geological work has been continued in the Minna-Gwari belt, and the mapping of the Alawa and the Zungeru standard sheets, an area of 2,400 square miles, has been completed. The geology closely resembles that of the adjoining Fuka sheet described in the half-yearly summary for January–July, 1928 (see BULLETIN OF THE IMPERIAL INSTITUTE, 1928, **26**, 482). Prospecting results from recent and ancient stream deposits related to the present river courses still continue to be disappointing, but the discovery of an auriferous conglomerate at the base of the Eocene Nupe sandstones has some potential economic interest. Considerable further work will be required to determine the extent and value of this deposit.

*Coal.*—The survey of the coalfield has been continued north and west of Enugu and has shown an extension of the coal series in both directions. Several new outcrops have been located, one of which is of workable thickness. It occurs in the escarpment east of Opi, in a locality where outcrops of coal are rare and shows that the series is unbroken to Okwoga. The series steadily increases in width from east to west as it passes northwards.

*Oil.*—A seepage of oil, a sample of which was examined by the Imperial Institute, was investigated at Ngusu in Ogoja Province. A pool of oil was formed in a small stream bed, and pitting showed that the oil seeped from a layer of impregnated sub-soil on the right bank. More extensive investigation of the occurrence is to be undertaken. Analysis has shown the oil to be of a heavy residual variety.

*Water Supply.*—The Water Supply Section commenced work in February in Sokoto Province and by the end of July 1,400 ft. of wells had been dug and lined, giving seventeen producing wells in the Gundumi Bush, in Sokoto and on the waterless stretch of the Sokoto-Zaria motor road. Further geological work undertaken tends to confirm the absence of artesian conditions, and efforts are now being made to exploit in the most economical manner such other sources of water as exist. An exploratory deep shaft is being dug in Sokoto City to investigate the possibility of a deep-seated aquifer that will provide an ample and safe water supply for Sokoto. There is already an indication that the present known aquifers, two in number, are being so heavily drained that their yield is decreasing. A new fossiliferous horizon with vertebrate and invertebrate remains of species hitherto unknown in Nigeria has been discovered, and collections

have been made for examination and determination at home.

### SOMALILAND

The Imperial Institute has received from Mr. R. A. Farquharson, Director of Agriculture and Geologist, a report on the research work carried out by his department during the six months ending December 31, 1928, and from this the following notes have been prepared.

*Gold.*—The presence of a small amount of gold in a sample of gum had been reported previously (see p. 379) and an effort was made to locate the source of the precious metal. It was ascertained that the consignment of gum in question had been collected from four main localities, viz. Haduya, Bokhun, Tug Bululoah and Tug Had, all being situated in the foothills close to the main escarpment south of Hias and Mait. A consideration of the mode of collection and transport to the point of shipment indicated that it was unlikely that the gold had been picked up by the gum after the latter had been collected from the vicinity of the trees.

The beds of the chief tugs in each of the four localities were prospected for gold by panning, but no colours were obtained. Nearly all the ridges in all four localities consist of more or less metamorphosed slates, which range in colour from light grey through greenish-grey, dark green, purple to nearly black; these mostly dip vertically and strike uniformly north and south, and are in places traversed by intrusions of granite and amphibolite dykes, and aplite or felsitic porphyry veins. A few ridges north of Haduya and Bokhun towards Hais and Mait are composed of granite or of Eocene limestone. In places, especially on the north-west side of Haduya, black-spotted (probably chistolite) slates of a purple colour, and greyish, purplish and nearly black phyllitic slates, occur among the alluvial deposits in the tug beds, but sufficient time could not be spared to search for them *in situ*. The spotted slates are probably contact phenomena in proximity to a granite or aplite dyke.

The whole of the slate series is seamed with quartz reefs, quartz veinlets, aplite, granite and greenstone dykes, almost all of which occur parallel to the bedding planes of the slates, though a few of the quartz veinlets are to be found along joint planes, more or less at right angles to the bedding. The quartz reefs and veins are of the following kinds:

(a) White "buck" quartz reefs, probably directly connected in origin with the larger granite intrusions noticeable at the bottom of the main escarpment. Some

of these are several feet in thickness, and all of them are, in part, ferruginous, with oxide of iron in powdery masses in cracks and vesicles.

(b) Water-clear quartz reefs up to two feet in thickness, not clearly connected with any intrusion, but, in many cases, containing patches of chloritic material. These are also very ferruginous with oxide of iron in cracks and sintery or vesicular patches.

(c) Water-clear and sugary quartz veinlets clearly arising from aplite or felsitic porphyry vein intrusions. These veinlets are in considerable numbers in the slates, wherever the vein intrusions occur. They are all ferruginous and vesicular or sintery.

Numerous reefs and veins were examined, and samples of them were collected and sent to the Imperial Institute for assay.

*Petroleum.*—In November, a party including two geologists and a surveyor, members of the staff of the Anglo-Saxon Petroleum Company, began work on the petroleum concession granted to the company at Dagh Shabell. The work of the party was to make a thorough geological examination and survey of the Dagh Shabell field with the object of determining its structure, the formations in which the oil originated and those which now contain it, and the most suitable locations for test boring. These necessary preliminary operations are not yet concluded, but it may, however, be permissible to remark that the work already done tends to show that the Tertiary formations play a more important part in the genesis of the oil than has hitherto been supposed.

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## ABSTRACTS OF RECENTLY PUBLISHED LITERATURE ON AGRICULTURE AND FORESTRY

*In this section a summary is given of the contents of the more important recently published papers and reports relating to tropical agriculture and forestry. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.*

### AGRICULTURE

#### OILS AND OIL-SEEDS

**Aleurites montana.**—A small area of land at the Government Plantation, Serdang, was planted with seedlings of *Aleurites montana* Wils. early in 1925. A record of their growth and behaviour up to the end of

1928 is published in the *Malayan Agricultural Journal* (1929, 17, No. 2, p. 47). The seedlings were raised from two consignments of seed received from the Botanical and Forestry Department, Hong Kong, in December 1923 and November 1924, respectively. Fifteen per cent. of the first lot germinated and 45 per cent. of the second. The seeds were sown in seed-boxes and the seedlings transplanted into bamboo baskets. The land allotted to the crop was an area of  $3\frac{1}{2}$  acres situated at the base of a somewhat steep hill. The soil was a heavy laterite loam. The area was lined and holed at a distance of 20 ft. by 20 ft., square planting, allowing 108 trees to an acre. Large holes were dug and a basket of cattle manure was placed in each. The seedlings were planted out in March 1925. A number failed to become established and during the ensuing planting season (November 1925), 20 per cent. of the holes were replanted. After planting growth was rapid, especially in the case of trees on the lower part of the area. One tree flowered in March 1926 and produced a few mature fruits in April 1927. A number flowered in 1927 and a few pounds of seed were collected in that year. More trees flowered early in 1928, and in the following June about 35 lb. of dried seeds were harvested from five of the largest trees. In August of that year a number of trees were flowering freely, and at the close of 1928 the majority had reached the flowering stage and a number of trees had produced fruits, one of them bearing about a hundred. About 160 seeds, after sun-drying, weighed one pound, which is approximately the same weight as the seeds originally received from Hong Kong. The fruits usually contained three seeds. The average height of the trees at the end of 1928 was 15 ft., and the average spread 7 ft. The average circumference of the trunk at 2 ft. from the ground was 16 in.

Early in 1928 an attempt was made to bud scions of *A. montana* on to the stocks of the indigenous *A. triloba*, the candlenut tree. Of the 65 stocks so budded, 27 appeared to be successful. After cutting back the upper portion of the stock, a growth of one to two inches took place and a number of the successfully budded plants were transferred to the field. All these trees, however, as well as those remaining in the nursery, died during the subsequent dry season. Further experiments on these lines are to be made.

These trials with *A. montana* have indicated that, although the trees have made comparatively rapid growth and are now producing fruit, this species of Aleurites is

not altogether suited to the conditions prevailing on the plains in Malaya. It will, however, take some time to decide this point.

**Caryocar villosum.**—An account of the introduction of *Caryocar villosum* ("Piqui-a") into Malaya is given in a recent issue of *The Planter* (1929, 9, No. 10, p. 278). This large deciduous tree is indigenous to Brazil where it grows on the higher lands of the somewhat inaccessible parts of the forests. Seeds were first planted in Malaya on the Birkhall Estate, Kedah, in 1919, and for the most part have grown well, the trees now being from 40 to 45 ft. high with a spread of the same distance. The first fruits matured in 1925, and since that time the annual crop has increased, thereby enabling the planted areas to be extended. The simplest method of propagation is by sowing seed. The use of cuttings is not recommended, but propagation by marcottage of the branches has been employed with success on a considerable acreage. The fruits, when mature, fall to the ground during October and November, and are gathered and brought to the factory. They are large and fleshy, weighing on an average 11–12 oz. each. At the factory the fruits are cut open to separate the large kidney-shaped nuts, of which each contains from one to four. These nuts are coated with a layer of fat which is removed on passing them through a specially designed machine, known as the "Birkhall Decorticator." This machine is capable of dealing with 100 nuts or more in one charge and brushes them free from the fatty layer within 10 minutes. The fatty material after drying is treated by the solvent extraction process and the pure fat thus obtained.

C. D. V. Georgi has recently examined a sample of these fruits grown in Malaya (*Malayan Agric. Journ.*, 1929, 17, No. 6, p. 166). They were found to be composed of: husk and outer layer of pericarp, 73.9 per cent.; inner layer of pericarp, 13.1 per cent.; shell, 11.3 per cent.; kernels, 1.7 per cent. The outer layer of pericarp and husk contained 9 per cent. of tannin, equivalent to 33 per cent. calculated on the moisture-free material. The inner pericarp which immediately surrounds the nut, yielded on extraction with petroleum ether 47.4 per cent. of a reddish-orange oil (corresponding to 72.3 per cent. expressed on the moisture-free material). The kernels gave on extraction with chloroform 45.1 per cent. of a yellowish, semi-solid oil, equivalent to a yield of 61.4 per cent. calculated on the moisture-free kernels. The peri-

carp and the kernel oils gave the following analytical figures :

	Pericarp oil.	Kernel oil.
Specific gravity at 99/15° C.. . . .	0.8622	0.8617
Melting-point (complete fusion) . . . .	27-28° C.	31-32° C.
Saponification value . . . . .	204.9	202.9
Iodine value (Wijs) per cent. . . . .	46.6	52
Free fatty acids (expressed as oleic acid), per cent. . . . .	1.1	0.2
Unsaponifiable matter, per cent. . . . .	0.7	1.3
Solidifying point of fatty acids . . . . .	48° C.	—

These results show that the constants of the pericarp oil agree closely with those for palm oil, and it appears probable that the former oil could be used for similar purposes to those of the latter, while the kernel oil could also be employed for edible purposes.

**Coconuts.**—Preliminary experiments have been carried out in Fiji on the pollination of the coconut palm with a view to developing improved seed-nuts, and the results are published in the *Fiji Agricultural Journal* (1928, 1, No. 2, p. 16), and are summarised as follows. Coconut pollen germinates best in a 25 per cent. saccharose solution containing 4½ per cent. of gelatine. Clean pollen from a healthy palm, stored in a desiccator containing 35 per cent. sulphuric acid, was found viable after 16 days with a germinating power in the above-mentioned solution of from 35 to 60 per cent. Uncontrolled pollination is established by wind as well as by insects, especially by bees and small fly. Bee-keeping ought, therefore, to be encouraged among coconut planters. For controlled pollination only pollen of a high vitality should be used. Coconuts can be grown in Fiji by means of artificial pollination. Uncontrolled selfing is possible with Malayan Dwarfs, but not with Niu Lekas and Rotumas. Controlled selfing is theoretically possible with any coconut variety as long as the interval between the male and the female phase of the same spathe is less than 16 days. The results obtained in Taveuni with cross pollination between Malayan Dwarfs (female) and Niu Lekas (male) were 27¼ per cent.; between Niu Lekas (female) and Malayan Dwarfs (male) 34.1 per cent., and between Rotumas (female) and Rotumas (male) 30.9 per cent.

**Irvingia sp.**—Two species of *Irvingia* occur in Indo-China, namely, *I. Malayana* Oliv. and *I. Oliveri* Pierre. The former is found more especially in Cambodia, while the latter is more widely distributed. The fat from *I. Oliveri* seeds has been used for very many years by

the natives for making candles (*Bull. Ag. Gén. Col.*, 1928, 21, No. 239, p. 1251; see also this BULLETIN, 1929, 27, 109). The fruits from this species are allowed to drop from the trees and to remain there in heaps for some time (about two months) in order to separate the mesocarp from the nuts. The nuts are then dried in the sun and, when dry, are opened by a strong knife or broken with a mallet. The cracking is rather difficult owing to their hardness. After a further drying in the sun, the kernels are freed from their seed-coats, pounded in a mortar, steamed, and pressed in a crude native press. The cake is used as a fertiliser, a feeding-stuff, or a fuel. A sample of the nuts obtained from Cambodia was examined with the following results. Shell 87.9 per cent.; kernel 12.1 per cent.; oil in kernels 58.1 per cent., corresponding to a yield of 7.0 per cent. calculated on the whole nuts. The oil at ordinary temperatures is a whitish, solid fat. Its iodine value is 5.8 per cent. and its saponification value 249.5. The fat prepared from *I. Oliveri* kernels gives analytical figures very similar to those of the fat from *I. gabonensis* kernels. It is considered that the fats from all species of *Irvingia* can be used for edible purposes and for soap manufacture. The small proportion of kernels and the hardness of the shell are obstacles to the development of their use.

**Oil-Palms.**—Details are given in *Der Tropenpflanzer* (1929, 32, 31) of a Dutch patent, taken out by the Rubber Cultuur Maatschappij, Amsterdam, for the preparation of palm oil. According to the information supplied regarding this process, palm fruits after being steamed and beaten are treated in a stirring apparatus with 50 per cent. of their weight of water in order to reduce the pericarp to a pulp. The mass is then transferred to a machine in which the nuts are separated from the pulp. The nuts leave the machine in a very clean and oil-free condition, and the efficiency of the machine is such that better results are obtained than by dry separation. The mixture of pulped pericarp, oil and water flows from the machine into a tank, fitted inside with a smaller tank perforated with holes, which serves as a filter. Water and oil collect in the outer tank and are subsequently drawn off by means of a tap at the bottom and separated in the usual way. The wet mass of pulp remaining behind in the inner tank is warmed in an apparatus fitted with stirring gear, and is then pressed. Alternatively, the oil and water may be separated centrifugally from the mass. The advantages claimed for this process are:

the necessary apparatus is simple and cheap and its upkeep is inexpensive. The process is easy and does not demand much supervision. The costly drying machinery, which is necessary when dealing with Sumatra fruits, is avoided. The oil obtained is all of one quality, which is not the case when the pulp is pressed more than once or is extracted. The efficiency is very high, a yield of about 97 per cent. of the available oil being obtained.

Jamieson and McKinney (*Oil and Fat Industries*, 1929, 6, No. 6, p. 15) have carried out an investigation of the characteristics and composition of palm oil. The oil employed was a sample of H. C. B. Plantation Palm Oil from Port Maladi, Belgian Congo. The authors obtained the following figures: specific gravity at 25/25° C., 0.9146; refractive index at 40° C., 1.4578; acid value, 20.65; saponification value, 197.9; iodine value (Hanus), 53.7 per cent.; unsaponifiable matter, 0.39 per cent.; Reichert-Meissl value, 0.10, and Polenske number, 0.29. The oil was found to be composed of glycerides of oleic acid, 47.2 per cent.; linolic acid, 5.6; myristic acid, 0.5; palmitic acid, 40.8; stearic acid, 5.2, and lignoceric acid, 0.1 per cent. It is pointed out that this is the first time that the presence of the last-named acid has been detected in palm oil.

**Olives.**—Trials carried out at the Experimental Oil Mill at La Ghaba, Tunis, have shown that when olive pulp is pressed in the finishing presses only, the yield and quality of the oil are similar to those obtained when the material is treated to a preliminary pressing in a preparatory press prior to treatment in the finishing press, and that the preparatory presses might therefore be dispensed with, thereby reducing the amount of labour required. Further trials are to be made (*Bull. Mat. Grasses, Marseille*, 1929, Nos. 1-2, p. 46). Other experiments were carried out to determine the effect on the yield of oil of breaking the fruits prior to treatment in a mill. Although the results were inconclusive, the general impression was that no advantages accrued. A fresh series of trials is to be made. The efficiency of a new apparatus, invented by M. Galimberti of Tunis, has been investigated, the object of which is to wash olives free from dirt and to remove leaves. In working the apparatus the olives are distributed from an upper screen in a thin sheet by means of a guide and a slowly rotating roller, and are submitted to the action of a strong current of air whereby

leaves and light impurities are removed. The fruits fall on to a perforated iron sheet, the holes of which are large enough to allow the fruits to pass through, but small enough to retain large impurities, such as stones or lumps of earth. On this metal sheet the olives may also be washed by jets of water under pressure. The fruits falling through the perforations drop on to an inclined plane and thence on to the washing table. This table is constructed of metal rods placed just sufficiently far apart to allow the passage of the washings, and the angle of its inclination is capable of being adjusted. Above the table are arranged four perforated pipes through which water is forced under pressure. The table is actuated by a reciprocating mechanism. On this table the olives are washed free from dirt, the fruits slowly roll down the incline and the washings pass through the interstices. The output of the plant is from 1,800 to 2,250 kilos. of olives per 24 hours, and the quantity of water required is 400 litres per 450 kilos. of fruit. The results of trials were entirely satisfactory.

**Palms.**—The subject of diseases affecting palms in Malaya is dealt with in a comprehensive illustrated article by A. Sharples in the *Malayan Agricultural Journal* (1928, 16, 313). The first part of the article is devoted to a review of the known diseases of coconut palms and oil-palms in countries other than Malaya. This is followed by an account of early observations on diseases affecting tall coconut palms in Malaya. Previously many cases of "bud-rot" of these coconut palms have been attributed to "Lightning Strike," but it is now considered that this disease is probably due to a fungus, *Marasmius palmivorus* Sharples, especially in cases where a large number of trees (e.g. 50 to 200 trees in a solid block) have been affected. This fungus also attacks dwarf coconuts and oil-palms. A description of the fungus is given, together with a detailed account of the symptoms caused by an attack. As regards control measures, the only ones that can be adopted are those designed to clear away vegetable debris and decrease atmospheric humidity in places where the fungus is growing strongly. Affected palms should be cleared up by removing all diseased material, which should then be burned. If the weather is too wet to allow burning, the material must be treated with a 5 per cent. solution of Izal or copper sulphate, and stored in heaps until it can be destroyed by fire. In conjunction with these sanitation methods, measures designed to improve soil conditions should be undertaken,

such as applications of a lime and fish manure mixture. Other fungi associated with palm diseases in Malaya are *Polyporus ostreiformis* Berk. found on areca, Royal and coconut palms, and *Absidia Butleri* Lend. and a fungus of the *Acremoniella* type, both of which have been isolated from diseased coconut palm roots. The present position in Malaya as regards diseases of palms may be summarised as follows: (a) Up to the present there is no evidence of an epidemic "Bud-rot" disease caused by a species of *Phytophthora* on any type of palm. (b) *M. palmivorus* is the direct cause of a disease on African oil-palms and dwarf coconut palms, and is a primary factor associated with various affections on tall coconut palms. (c) *P. astreiformis* is a fungus commonly associated with a root and stem disease on areca palms and has been found associated with affections of coconut palms. (d) There are also several peculiar affections with which various organisms, both bacterial and fungoid, are associated.

**Tung Oil.**—An oil-mill has recently been completed at Gainesville, Florida, to handle the crops of tung oil nuts from the plantations of the Alachua Tung Oil Corporation and the American Tung Oil Company, the trees of which have just come into bearing (*Oil and Fat Industries*, 1929, 6, No. 2, p. 27). In this mill the unshelled nuts are fed by an elevating conveyor into a hopper above a rotary decorticator, which removes the shells, permitting the kernels and shells to fall by gravity on to a shaking screen below, from which the shells are removed by an air-suction conveyor to the fuel-pile outside the building. The shells form the chief source of fuel for working the plant. The kernels are conveyed from the separating screen to a set of cracking rolls where they are rolled just sufficiently to enable the oil to be efficiently expelled subsequently. From these rolls the crushed kernels pass to the tempering apparatus, where they are subjected to slight heating, and then to the expeller in which the oil is expressed. The oil flows by gravity into receiving tanks for subsequent filtration and shipment, while the expeller cake is automatically conveyed to grinding and sacking machinery for sale as meal.

#### ESSENTIAL OILS

**Camphor.**—With a view to studying the economic possibilities of the production of camphor in the Dutch East Indies, I. W. Spoon has made a survey of experiments which have been carried out in that region regarding

the cultivation of *Cinnamomum Camphora* (Mededeeling No. 25, *Afdeeling Handelsmuseum*, No. 7, 1929. *Koninklijke Vereeniging Koloniaal Instituut, Amsterdam*).

*C. Camphora* was introduced into Java and Sumatra many years ago from Japan, and has been found to succeed well in several parts of these islands. At the present time several plantations of young trees exist. At Buitenzorg there are a few old trees and a number of young trees, and in the mountain gardens at Tjibodas, where the best cultural results have been obtained, there is a group of trees of about 20 years old. In 1908 a small scale distillation of clippings from three-year-old plants grown at Tjibodas furnished the following results. The leaves (115 grams), containing 18.6 per cent. of moisture, yielded a total distillate of 4 c.c. from which 1.8 grams of solid camphor was obtained. The twigs (75 grams), containing 27.8 per cent. of moisture, gave a total distillate of 0.5 c.c. from which 0.2 gram of camphor was separated. This is equivalent to a yield of 2.3 per cent. of camphor and oil, or over 1 per cent. of camphor from the entire clippings.

The most important distillation which has taken place in these Islands was carried out by de Jong at Buitenzorg in 1912. From 3,560 kilos. of fresh leaves, procured from a plantation at Tjipetir, were obtained 31.15 kilos. of camphor (equal to 0.9 per cent.) and 14.1 litres of oil. These yields are shown to compare very well with those obtained from camphor leaves distilled experimentally in British and French Colonies, and the author states that the Dutch East Indies would be well suited for the cultivation of the camphor tree.

The author reviews the present position of camphor, its uses, and the world's requirements, and with the help of statistics draws attention to the strong position of the Japanese monopoly and the firm hold which synthetic camphor has gained on the world's markets. In view of these existing sources of production, the author is unable to recommend at present any definite cultivation of the camphor tree in the Dutch East Indies; he advocates, however, its planting as a shade tree for coffee and other crops in preference to other trees which have little or no potential commercial value.

**Clove Oil.**—Reference has been made in this BULLETIN (1928, 26, 323) to an account of the clove industry of Madagascar by V. H. Kirkham, Director of Agriculture, Zanzibar, who visited this French Colony in 1928. Further information on the subject is contained in an article by

Ledreux, published in *Bulletin Économique, Madagascar* (1928, 25, 38). The chief centres of clove cultivation are stated to be the island of Sainte Marie and the region of Soanierana. The clove is believed to have been introduced into Sainte Marie about 70 years ago from Réunion or Mauritius. Bad cultivation in the past furnished poor results, but owing to the encouragement given by the Government the culture has rapidly developed on more scientific lines, and is at present the only industry in the island.

The harvest commences about October 15, and lasts till the end of December. The cloves with the stalks are picked when faintly pink, and then separated from the stalks and dried in the sun for 2 to 4 days. By keeping the height of the trees below 4 to 5 metres, and allowing the lower limbs to develop, children may be employed to gather the crop when labour is scarce and expensive. A good deal of the crop has, however, to be collected before the cloves are sufficiently mature, owing to shortage of labour.

It is reckoned in Sainte Marie that to every 3.5 kilos. of green cloves there are 20 kilos. of stems. In 1928 the cloves were bought at from 4.25 fr. to 5.00 fr. per kilo., and the stems at 1.25 fr. per kilo. That year the clove harvest in Sainte Marie amounted to about 600 tons or about 60 kilos. per tree, which is stated to be the maximum that is likely to be obtained in the island, as the number of pickers who come from Madagascar is growing less each year as they possess their own plantations in the latter island. The cloves not harvested amounted to about one-eighth of the production.

A large quantity of the stems and defective cloves are distilled on the spot. Besides the dead leaves collected under the trees, the upper branches of the trees with their leaves are distilled, the air-dried material yielding 2 to 3 per cent. of oil. A large and increasing number of stills exist in Sainte Marie. They have a capacity of from 200 to 2,000 litres, and are heated by direct fire.

In Soanierana the plantations are generally much better established than in Sainte Marie, and are the oldest in Madagascar, being about 25 to 30 years old. Well developed trees of more than 15 years old produce from 2 to 3 kilos. of cloves per tree. The writer considers that the output of cloves from Madagascar will never exceed 3,000 tons as the plantations, which are chiefly along the East Coast, suffer seriously from periodical cyclones, and that the sparse population is also a permanent obstacle to larger production. He states that Mr. Kirkham

informed him that in his opinion if the world production does not exceed 12,000 tons, the market will continue to be stable, but that fresh demands must be created to ensure good profits for the producer. Madagascar cloves fetch a higher price than Zanzibar cloves, as they have a better aroma, for the more humid climate of Zanzibar renders more difficult the drying of the cloves.

## FIBRES

*Sisal Hemp*

The following particulars regarding the sisal hemp industry of Kenya are given in the *Ninth Ann. Rep., Agricultural Census, Colony and Protectorate of Kenya*, 1928. The area under cultivation on July 31, 1928, amounted to 91,909 acres, and the production of fibre during the year ending on that date was 14,737 tons, distributed as follows :

	Area. Acres.	Production. Tons.
<i>Coast Province :</i>		
Digo . . . . .	2,075	100
Malindi . . . . .	3,115	1,160
Mombasa . . . . .	1,200	132
<i>Kikuyu Province :</i>		
Fort Hall . . . . .	28,342	4,225
Kyambu . . . . .	21,385	2,783
<i>Nyanza Province :</i>		
Central Kavirondo . . . . .	185	0
<i>Ukamba Province :</i>		
Kitui and Machakos . . . . .	9,392	3,277
Nairobi . . . . .	2,240	145
Teita . . . . .	5,851	1,439
<i>Extra-Provincial Districts :</i>		
Kisumu-Londiani . . . . .	3,351	263
Naivasha . . . . .	5,100	500
Nakuru . . . . .	4,682	270
Nyeri North . . . . .	200	0
Trans Nzoia . . . . .	3	0
Uasin Gishu . . . . .	4,788	443

During the year under report, the total area under cultivation increased by 20,696 acres, or 29.06 per cent., which is the greatest annual increase so far recorded in the industry. The estimated production for the year 1928-29 is given as 18,250 tons.

The exports of sisal during the year 1927-28 amounted to 14,510 tons as compared with 15,549 tons in the preceding year ; the decrease was due to a fall in the market price of the fibre.

*Urena lobata*

A note on *Urena lobata* fibre and its production in Madagascar, issued by the Government General of Madagascar, has been published in the February issue of *Rev. de Bot. Appl. et d'Agric. Trop.* (1929, 9, 31).

*Urena lobata*, or "Paka" as it is termed in Madagascar, produces stems ranging in height from 2 ft. to 10 ft. The seeds ripen at the beginning of April; they fall to the ground and germinate in December at the commencement of the rainy season. The resulting plants can be exploited in the following year.

In 1926 an ordinance was promulgated prohibiting the harvesting of "Paka" between January 1 and May 31. The collection of the stems therefore commences at the beginning of June and is continued until December, even after the plants have become dry; the fibre obtained from the earliest cuttings, however, has a higher commercial value than that produced at the end of the season. A native can cut 200 kilos. of stems per day, and it is estimated that 100 kilos. of the green stems furnish 7-8 kilos. of dry fibre. One worker can prepare 5 kilos. of fibre per day.

In preparing the fibre, the stems are first dried in the sun until the leaves have fallen off and are then immersed, preferably in running water. The duration of the retting varies from 5 to 20 days, according to the age and size of the stems and the temperature. At the conclusion of this operation, the bark is peeled off from the base upwards and well washed to free the fibre from extraneous matter. In order to secure a fine, yellowish-white appearance, the fibre is treated with slightly acidulated water, the natives using lemon juice for the purpose. The fibre is then wrung out and hung up to dry.

The following quantities of "Paka" fibre have been exported from Madagascar during recent years:

Year.	Quantity. Kilos.	Year.	Quantity. Kilos.
1919 . . .	16,545	1924 . . .	636,205
1920 . . .	77,764	1925 . . .	857,560
1921 . . .	61,866	1926 . . .	2,361,248
1922 . . .	58,630	1927 . . .	1,374,715
1923 . . .	133,192		

The cultivation of "Paka" is not undertaken by European planters, owing to the difficulty of recruiting the necessary labour, especially for harvesting. The natives, however, with the help of their families, could considerably increase the area planted and obtain good profits. The development of the industry will be accelerated when the use of the plough becomes more general. The areas on which the wild plants occur are becoming more numerous, but only those near lines of communication can be profitably exploited. The price of the fibre varies from 2,000 to 2,400 frs. (£16-£19) per ton, f.o.b.

Estimates of the costs of production are given, showing

the total cost per hectare to be 1,120 frs. Assuming an average yield of 800 kilos. per hectare, the cost per kilo. would be 1 fr. 40. It is pointed out that the production of "Paka" fibre would increase considerably if a sufficient price were offered for it, and it is suggested that it might be used locally for the manufacture of bags which are now imported in large quantities.

### *Mohair*

A valuable monograph on "The Angora Goat and Mohair Industry," issued jointly by the U.S. Department of Agriculture and the U.S. Department of Commerce, has appeared as *Miscellaneous Circular No. 50, U.S. Dept. Agric.* (Washington, D.C., March 1929). It was prepared jointly by (1) the Bureau of Agricultural Economics, the Bureau of Animal Industry and the Forest Service, of the Department of Agriculture, and (2) the Bureau of Foreign and Domestic Commerce and the Bureau of Standards, of the Department of Commerce.

Reference is made to the importance of the Angora goat industry in the United States, the composition and characteristics of mohair fibres, the world distribution of Angora goats and the development of mohair production in the United States. Information is also supplied regarding the management and improvement of Angora goats and the losses occurring among goats due to poisonous plants, predatory animals and diseases. Particulars are given of the marketing of Angora goats and mohair, and of the international trade in them. The standardisation of mohair grades is discussed and a short account is given of the processes for manufacturing mohair fabrics. The work concludes with a bibliography of the literature quoted. The circular contains some good illustrations, and gives the following summary.

Specialised production of Angora goats and mohair has been developed primarily in Turkey, the Union of South Africa and the United States. Many attempts have been made to establish Angora goats in Europe, but none of these attempts were successful. From the dawn of history until after the middle of the nineteenth century the region known as Angora in Turkey was the only important Angora-goat country. The Union of South Africa secured its first small importation of Angora goats from Turkey in 1838, and the initial importation of this breed of goats into the United States came from Turkey in 1849.

The Turks were reluctant to export these mohair-

bearing animals, and development in other countries was comparatively slow until about the close of the nineteenth century. By 1900 breeders in the United States and South Africa were making important progress. At that time the registration of pure-bred Angoras was established in both these countries, and since that time these two countries have enjoyed a steady and substantial improvement in this breed. There have been no importations of Angoras from Turkey into the United States since 1901. In 1904 there was a large importation into the United States from South Africa. Importations of Angora goats into the United States then ceased for a period of twenty-one years, the next and last foreign goats being received from South Africa in 1925.

Angoras have been raised in all regions of the United States. In 1920, every one of the forty-eight States reported fleece-bearing goats, but approximately 90 per cent. of them were in the South-west and the Pacific coast region in Texas, New Mexico, Arizona, California and Oregon. Missouri had about 3 per cent. of America's fleece goats, and in all other States they were of minor importance. The greatest concentration is on the Edwards Plateau of south-western Texas, where about 70 per cent. of them were found in 1920.

The expansion of the industry in the United States has been accompanied by improvement of the goats and their fleeces. The average annual fleece weights were about 19 per cent. heavier in 1927 than in 1920. Breeders are also giving attention to the improvement of quality in the mohair, including the elimination of kemp.

The pioneer phase of the industry is passing. A large percentage of the goats are grazed on owned or leased lands. The investment in goats and equipment is so great that wasteful methods will lead to failure. Goats must be handled with care and in accordance with the results of scientific investigation if the venture of mohair production is to prove profitable. In the six important mohair-producing States the number of fleece goats increased nearly 35 per cent. and the production of mohair 59 per cent. from 1920 to 1927.

There is a healthy demand for mohair fabrics, and manufacturers are eager for mohair of high quality, but improvement in the quality of the goats and their fleeces, increased efficiency in production and marketing methods, and the establishment of official United States standards for grades of mohair are of primary importance to growers and to the industry as a whole. Recent expansion has been so rapid that caution should be exercised in the

matter of increasing the numbers of Angora goats except as would be justified by increased demand for mohair.

### TANNING MATERIALS

**Wattle Bark.**—A series of investigations concerning the composition and chemical properties of black wattle bark grown principally in the Midlands of Natal has been carried out by C. O. Williams (*Science Bulletin* No. 63, *Dept. Agric., Un. S. Africa, Division of Chemistry, Series No. 82*, 1928). Mature freshly gathered wattle bark was shown to contain on an average 53 per cent. of moisture, the greatest amount of moisture being found usually in the bark from the middle of the tree. When dried under natural conditions the bark loses about 48 per cent. of its original weight. The average weight of air-dried bark obtained per tree varied from about 8 lb. in the case of three-year-old trees, up to about 40 lb. from a tree nine years old. The average percentage of tannin in bark from trees between these ages was not found to vary a great deal, nor with trees of the same age was any appreciable difference observed in the tannin content of the bark whether stripped in the summer or in the winter. The amount of tannin in the bark showed a decided decrease from the base of the tree upwards, the bottom third of the trunk containing usually more than half the tanning matter obtainable from the complete tree. The percentage of tannin increased with the thickness of the bark in trees from 3 to 12 years old, provided it had not become very corky, but the tannin content for any particular thickness of bark seemed to be greatest in young trees.

Williams has shown that the bark from the larger branches of mature wattles compares fairly well in tannin content with the bark from the top portion of the main stem; the leaves and twigs from mature trees contain only about 4 per cent. of tannin. Bark from trees affected with the common disease known as "mottling" usually contains appreciably less tannin than sound bark growing in the immediate vicinity, and invariably furnishes a darker extract. The deterioration, however, is not so marked as might be expected from the appearance of the bark. It was also found that stripped bark exposed to heavy rains loses chiefly soluble non-tannins, the tannin in the weathered bark being often higher than in the unweathered, and the former produces usually a paler extract. Moulds caused by drying the bark in wet weather have also the effect of decreasing the amount of

soluble non-tannins present, and as a result increase in the actual percentage of tannin present may take place. Moulds cause a marked deepening in the colour of the extract.

The Department of Agriculture, Union of South Africa, has reprinted as a separate pamphlet (*Reprint No. 1, 1929, Division of Chemistry, Series No. 92*) two articles which appeared in the October 1928 and January 1929 numbers of *Farming in South Africa*, entitled "Manuring of Wattles," by G. O. Williams, B.Sc., A.R.C.S., and "Fertiliser Trials with Wattles," by J. B. Osborn, M.Sc.

The former article describes preliminary experiments carried out on the Broadmoor Estate, Warburg, Natal, where the land had been under wattles for many years. It has a hillside soil, not particularly fertile. In one series of experiments the plantation was re-established in April 1926 and the various fertilisers employed broadcast on the soil. Comparative growth on the manured and unmanured plots was estimated at the end of the first and second years by cutting down some of the trees and weighing them.

As examples of the increased growth of trees on manured over unmanured plots, it may be stated that even the treatment showing the least effect (400 lb. of rock phosphate per acre) showed an increase of 86 per cent. at the end of the second year, whilst with 800 lb. superphosphate + 200 lb. potash per acre an increase of 263 per cent. resulted.

In a second series of experiments conducted a year earlier no actual weights or measurements of the growth were taken, but it was obvious to the eye that the trees on the manured plots made far better growth than those on the unmanured plots; three-year-old trees that were fertilised made as much growth as the ordinary four- or five-year-old trees on contiguous plantations.

Mr. Osborn's article deals with fertiliser trials carried out in the Richmond District, Natal, and near Seven Oaks, Natal, and in general confirm those obtained on the Broadmoor Estate.

The results of all the experiments recorded indicate that phosphate appears to be the chief requirement for wattles on the soils tried, superphosphate being superior to rock phosphate for this purpose, whilst the further addition of potash and sulphate of ammonia is also beneficial.

Up to the present it has not been common practice to apply artificial manures to wattle plantations, but these

experiments show that this treatment has beneficial effects in many directions as far as young trees are concerned, both on new plantations and in re-establishing plantations, though what the ultimate results may be with mature trees must as yet be a matter for conjecture.

## FORESTRY AND TIMBERS

**The Beech Forests of New Zealand.**—In a former number of this BULLETIN (1927, 25, 446) reference was made to Part I of a valuable monograph by Dr. L. Cockayne on the New Zealand beech forests. It may be recalled that the stands of beech (*Nothofagus*) in the Dominion are among the most important forest assets of the country both as sources of merchantable timber and as protection forests, and that the care and development of these forests call for serious attention at the present time. The first part of the monograph was concerned mainly with the scientific aspects of the question, including the elucidation of the species, of which excellent drawings were furnished. The second part deals with the forests from the practical and economic standpoints in the light of the information contained in those sections of the first part which have a bearing on this aspect of the question. A matter of first importance is a correct understanding of the nomenclature of the beeches composing the forests. On this point there has been great confusion in the past, often resulting in much loss and misunderstanding since the different timbers vary considerably in their technical value. Dr. Cockayne suggests the following standard names for the five species concerned and proposes that this nomenclature should be officially adopted by the State Forest Service and taught in the State schools. The names are silver beech (*Nothofagus Menziesii*), red beech (*N. fusca*), hard beech (*N. truncata*), black beech (*N. Solandri*), mountain beech (*N. cliffortioides*). The ecological factors governing the formation and maintenance of the forests are considered in detail. So far as rainfall is concerned, the bryophyte, filmy-fern and possibly the lichen contents of a forest afford perhaps the best index of the rainfall and give a clear indication of the suitability of the particular forest for the introduction of various kinds of trees, especially exotics. As regards light, it has been ascertained that the incoming of beech seedlings can be greatly increased by removal of undergrowth, while in protection forest the main object is to preserve and increase the undergrowth. Biological competition within the forests is severe. That occasioned by "weed" plants is not of

serious importance, but the menace of grazing and browsing animals and notably that of the red deer (introduced for sporting purposes) appears to be formidable. In order to cope with the deer, drastic methods of destruction are considered to be essential. In the section devoted to silviculture the maintenance and development of the commercial forest are discussed. The silver beech is to be placed first as an economic tree, since, although its timber is of poor durability when exposed, the tree is far less liable to damage by fungi than are the other species. The question of replacement of the beeches by exotic trees in virgin forest appears to be settled by the conclusion that the best and cheapest course is to allow the forest to regenerate naturally into its original botanical composition. In the many bare spaces which will be obvious when the forest is fully milled exotics should be grown, and in this connection the following are suggested: *Pinus radiata* (*P. insignis*), *P. ponderosa*, Douglas fir, *Cupressus macrocarpa*, *Chamaecyparis Lawsoniana*, *Thuja plicata* and *T. gigantea*. As regards the technical values of the timbers of the several beeches considerable differences are known to exist. Hitherto, there has been no great demand for beech timber, but an important trade is now arising in silver beech (*Nothofagus Menziesii*), chiefly as a furniture wood. This species, however, is not so durable as red beech (*N. fusca*), which has been used for sleepers and railway truck building. The hard beech (*N. truncata*) is regarded as even more durable than red beech, but is not much used; while the mountain beech (*N. cliffortioides*) is the least durable of the series though quite useful for box-making and other purposes where a cheap wood is the main requirement. The outstanding matter in regard to the employment of all the timbers is their satisfactory seasoning. A special section of the volume is devoted to a list of species of vascular plants occurring in the *Nothofagus* forests, giving their popular names, distribution and growth forms. This list is a most valuable feature of the monograph. The important part played by the ferns and Podocarpaceæ is clearly indicated, while not a few of the herbaceous and shrubby species will be familiar to English horticulturists. A useful bibliography closes the monograph which must come to be regarded as the standard handbook to the management of these valuable forests of New Zealand.

**African "Sandaleen" Wood.**—In *Tropical Woods* (No. 17, March 1, 1929), Dr. J. Burtt Davy describes a sample of fragrant wood derived from Portuguese East Africa

received by him for identification from Professor Record. The timber, which is known as Sandaleen wood, has been recognised as the product of *Spirostachys africana* Sond. (= *Excoecaria africana* Muell. Arg.), a small tree belonging to the family Euphorbiaceæ and reaching a height of 15–30 ft. with a straight, clean bole of a diameter of 6–16 in. The tree occurs widely distributed in South and East Africa, and outside Portuguese territory (including Angola) is recorded from Tanganyika Territory, South-West Africa and the Union of South Africa (Transvaal Bushveld, Swaziland, Natal, Pondoland and Transkei). In Portuguese East Africa available supplies are said to amount to at least 2,000,000 cubic feet of logs in lengths of 8–16 ft. and of an average diameter of 12 in. The timber has been used in South Africa, where it is considered a first-class material for gunstocks, furniture and wagon work, though it is much too valuable for the last-named purpose. On account of its very pleasant and durable scent, the wood is prized for making bead necklaces and charms, and should be useful for fancy boxes and similar objects. The wood, however, appears to contain an acrid, oily juice, and on this account has been found unsuitable for ox-yokes since it has a “burning” effect on the necks of the animals. The sawdust is said to affect the eyes of the sawyers.

**A Bibliography of Tropical Timbers.**—The steadily increasing demands upon the available stands of hardwoods of the United States has for long caused anxiety as to the maintenance of supplies, and it seems probable that a serious shortage will be experienced within the next few decades. Timber authorities in America consider that definite attention should be paid to the resources of the tropics in woods suitable for the timber-consuming industries, and emphasis is laid upon the availability of vast supplies of hardwoods, in greatest variety, in the comparatively near forests of tropical South America. It is considered, however, that a special difficulty in making use of these timbers results from the highly specialised technique which has been developed for dealing with the hitherto abundant hardwoods of the United States itself, a technique which is so rigid in its application as to exclude the utilisation of any wood whose physical qualities are not well known. A first step, therefore, towards utilising the woods of the tropics would be the collection of information regarding their properties. This was the position recognised by a special Committee set up as the outcome of the co-operation in 1925 of the Main Research

Committee of the American Society of Mechanical Engineers and the Tropical Plant Research Foundation. This Committee decided to compile a bibliography on the timbers of the world, exclusive of the temperate region of North America. The work has recently been published (1928) by the A.S.M.E. under the title of "A Bibliography of the Woods of the World." It is a book of 77 pages, and comprises references covering tropical forestry, lumbering, marketing, utilisation and characteristics as well as botanical information. The work has been compiled by Major George P. Ahern and Miss Helen K. Newton, of the Tropical Plant Research Foundation, and is arranged geographically. A most valuable series of references, with a useful subject index, is thus available and will be welcomed by all interested in tropical woods.

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### Timbers

The Uses of Home-Grown Timbers. *Publication of the Forest Products Research Laboratory, Department of Scientific and Industrial Research.* Pp. 36,  $9\frac{1}{2} \times 6$ . (London: H.M. Stationery Office, 1929.) Price 1s.

Commerce et Exploitation des Bois du Gabon. *Actes et Comptes Rendus de l'Assoc. Col. Sci.* (1929, 5, 60-66).

The West African Abachi, Ayous, or Samba (*Triplochiton scleroxylon*). By S. J. Record. *Tropical Woods* (1929, No. 18, 43-54).

Walnut Woods, True and False. By S. J. Record. *Tropical Woods* (1929, No. 18, 4-29).

Kiln Drying Handbook. By Rolf Thelen. *Dept. Bull. No. 1136, U.S. Dept. Agric.* Pp. 96,  $9 \times 5\frac{1}{2}$ . (Washington, D.C.: U.S. Government Printing Office, 1929.) Price 30 cents.

The Air Seasoning of Western Softwood Lumber. By S. V. Fullaway, Jr., H. M. Johnson and C. L. Hill. *Dept. Bull. No. 1425, U.S. Dept. Agric.* Pp. 59,  $9\frac{1}{4} \times 5\frac{1}{4}$ . (Washington, D.C.: U.S. Government Printing Office, 1928.) Price 20 cents.

Deterioration of Wind-Thrown Timber on the Olympic Peninsula, Wash. By J. S. Boyce. *Tech. Bull. No. 104, U.S. Dept. Agric.* Pp. 28,  $9\frac{1}{4} \times 5\frac{1}{4}$ . (Washington, D.C.: U.S. Government Printing Office, 1929.) Price 10 cents.

Indian Tariff Board. Match Industry. Vol. III. The Written and Oral Evidence by the Swedish Match Company, Bombay. Pp. 260,  $9\frac{1}{2} \times 6\frac{1}{2}$ . (Calcutta: Government of India Central Publication Branch, 1929.) Price Rs.3.4, or 5s. 9d.

Indian Tariff Board. Match Industry. Vol. IV. Views of the Local Governments and Miscellaneous Evidence. Pp. 605,  $9\frac{1}{2} \times 6\frac{1}{2}$ . (Calcutta: Government of India Central Publication Branch, 1929.) Price Rs.4.6, or 7s. 3d.

### Tanning Materials

The Tanning Industry of Cyprus. By M. T. Dawe. *Bull. No. 2, Industries Series, Dept. Agric., Cyprus.* Pp. 13,  $9\frac{1}{2} \times 6$ . (Nicosia: Government Printing Office, 1929.)

Contribution à l'Étude des Écorces Tannifères de la Guyane Française (cont.). By F. Heim de Balsac, A. Deforge, H. Heim de Balsac and L. Lefèvre. *Bull. Agence Gén. des Col.* (1929, 22, 119-137; 340-368).

Les Cæsalpinia's à gousses tannifères. By A. Chevalier. *Rev. Bot. Appl. et d'Agric. Trop.* (1929, 9, 298-302; 377-381).

The Mallett Forests of Western Australia. By A. C. Harris. *Australian Forestry Journ.* (1929, 12, 10-17).

Mangrove Forests of the Malay Peninsula. By J. G. Watson. *Malayan Forest Records*, No. 6. Pp. 275,  $10\frac{1}{4} \times 7\frac{1}{4}$ . (Singapore: Fraser & Neave, Ltd., 1928.) Price \$3, or 7s.

The Quebracho Industry of Argentina. Its Development and Prospects. By J. Pelisch. *Leather Trades' Review* (1929, 62, 336-338; 417).

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## NOTICES OF RECENT LITERATURE

AFRICA. By L. S. Suggate, B.Sc. Pp. 378,  $7\frac{3}{4} \times 5$ . (London, Bombay and Sydney: George G. Harrap & Co., Ltd., 1929.) Price 6s.

Students or general readers requiring a concise geography of Africa less condensed than the small work by Mr. Evans Lewin previously noted in this BULLETIN (1924, 22, 386) will find in the present volume a well arranged and very informative account of the continent. In his preface the author states that he has endeavoured to present a comprehensive and balanced study of Africa in the light of modern geographical thought and has emphasised particularly the economic aspect of the subject, whilst at the same time giving adequate treatment to physical and regional geography without neglecting the historical and human background. If any serious criticism can be levelled against such an admirable little work, it is that most of the maps are too small and diagrammatic and that there is no general political map of the entire continent. A folding map of this kind, preferably in colour, would be a valuable addition.

FOUR YEARS' FARMING IN EAST ANGLIA, 1923-27. By R. McG. Carslaw, M.A., with a Foreword by J. A. Venn, M.A. University of Cambridge, Department of Agriculture, Farm Economics Branch, Report No. 12. Pp. ix + 125,  $9\frac{3}{4} \times 7\frac{1}{2}$ . (Cambridge: W. Heffer & Sons, Ltd., 1929.) Price 3s.

This publication is described in a sub-title as "a detailed investigation of the costs and returns on twenty-six farms." It contains a large amount of statistical information, based on experience of the farms in question, regarding the cost of production of the principal crops and livestock and the yields and profits obtained; the results are discussed in relation to the various factors involved, and attention is drawn to their economic significance with respect to the general problems of arable farming in England.

THE TROPICAL CROPS. A Popular Treatment of the Practice of Agriculture in Tropical Regions, with discussion of Cropping Systems and Methods of Growing the Leading Products. By O. W. Barrett, B.Sc. Pp. xviii + 445,  $7\frac{1}{4} \times 4\frac{3}{4}$ . (New York : The Macmillan Company, 1928.) Price 17s.

The scope of this book, by the Agricultural Director, Department of Agriculture and Labour, Porto Rico, is clearly indicated by its sub-title. After a general brief discussion of tropical field practice and conditions, the geography and climate of tropical regions, and living conditions for the tropical planter, the various crops are dealt with in sequence. In the case of the more important crops, such as coffee, cocoa, tea, sugar-cane, citrus fruits, pineapple, banana, coconut, rubber and tobacco, particulars are given of their origin and botany, cultivation, harvesting, preparation, pests and diseases, and commercial outlook. Other products receive briefer treatment, although, owing to the great number dealt with, the chapter on tropical fruits (other than the pineapple and banana) is the largest in the book, occupying fifty pages. This may seem to some readers somewhat disproportionate in view of the fact that all the tropical fibres are dismissed in ten pages. As the production of cotton is not confined to the tropics the author does not discuss its culture and devotes little more than a page to it.

In the case of the less important products some improvement could have been made in their grouping. For example, there is no section devoted to oil seeds, which must be looked for under "Other Palm Products," "Other Tree Products" (a chapter which also includes such diverse products as cinchona bark, gutta percha, camphor and tropical nuts), "Grains and Forage," and "Miscellaneous Crops." Moreover, the author is not consistent, in the sections mentioned, for piassava is included under "Fibres" not "Other Palm Products," and tanning materials and dyestuffs derived from trees are given under "Miscellaneous Crops" and not "Other Tree Products." The author does not confine his attention to cultivated crops and many tropical products derived from wild trees are dealt with; timbers, however, are not included.

Three-quarters of this book, dealing with the more important crops, is extremely well done, within the limits of space at the author's disposal, and can be recommended as a good introduction to the more detailed treatises on the separate crops that are available. If a suggestion may be made it is that the next edition be confined to

the major crops and that a new book of equal size be devoted to the others, which although of relatively less value as measured by their out-turn, are nevertheless of great economic importance.

LE COTONNIER. I. VARIÉTÉS, HÉRÉDITÉ, HYBRIDATION, SÉLECTION ET BIOTAXIE DU COTONNIER. By Ray C. P. Boone. Pp. xx + 306, 10 × 6½. (Paris : Société d'Éditions Géographiques, Maritimes et Coloniales, 1929.)

This is the first of a series of volumes (four according to a statement in the preface, or five according to the introduction) which are being prepared with the object of presenting a complete account of our knowledge of the cotton plant, its cultivation and utilisation. As stated in the sub-title, the present volume provides information on the varieties, heredity, hybridisation, selection and biotaxy of cotton. The second volume will deal with methods of cultivation and harvesting, whilst the others will treat of ginning, pressing and baling, determination of strength, length and fineness, the cottons of commerce, the seed and the manufacture of oil and cake, insect pests and diseases, and the cultivation of cotton in the principal producing countries.

The first volume opens with a preface by Prof. E. de Wildeman, and a brief introduction by the author. It then proceeds to discuss the botanical classification of cottons, and the various classes into which cottons have been placed by American experts in accordance with some special characteristic. In the latter connection reference is made to the classification of cotton plants : (1) according to the form and development of the main stem and the number, growth and position of the lateral branches into such groups as long-limbed, short-limbed, cluster and semi-cluster, (2) according to the time taken to reach maturity—early and late varieties, (3) as to whether the bolls open completely when ripe, or never open completely as in the "stormproof" cottons, (4) according to the size of the boll—large, medium or small, (5) the form of the bolls, whether round, elongated, ovoid, pointed or mucronate, (6) the length of the cotton fibre—short-, medium- and long-stapled, and (7) according as to whether the plants are very prolific, prolific, or little prolific.

An account of the varieties and races of cotton is given under the heading of the following species : *Gossypium barbadense*, *G. hirsutum*, *G. herbaceum*, *G. arboreum* and *G. religiosum*.

After discussing the choice of varieties for planting, the author deals with heredity, hybridisation and selection.

The rest of the volume deals with the biotaxy of cotton, including the growth of the young plant, the growth during the fruiting period, the production of squares, and the number of flowers borne by the plants at different intervals of growth.

The work contains a large store of information and appears to have been carefully compiled. It is well illustrated and a useful bibliography is appended.

SPINNING, WEAVING AND FINISHING OF FLAX AND JUTE. By Thomas Woodhouse, F.T.I., and Peter Kilgour. Pp. vii + 206,  $8\frac{1}{2} \times 5\frac{1}{2}$ . (London : Sir Isaac Pitman & Sons, Ltd., 1929.) Price 10s. 6d.

This work gives a useful account of the various processes involved in the manufacture of jute and flax, including a description of the machinery employed and the methods of effecting the calculations necessary in connection with the preparing and spinning operations. The book is excellently illustrated and should prove of considerable value to students of the textile industries.

In one respect, however, the book may perhaps be open to criticism. It would appear that the authors' endeavour to treat of jute and flax together may tend to create confusion in the mind of the student. The following paragraph occurring on page 9 may be quoted as an example of this : "The plants—or *straw* as they are sometimes called—whether of jute or flax, are made up into conveniently-sized bundles, and these bundles are placed in slow-running streams, pools or ponds. In other cases the plants are loosely spread in fields to be dew-retted, in which case they are occasionally turned over so that all parts may be uniformly affected by the climatic conditions." Such a statement is apt to mislead as it gives the impression that jute stems are termed "straw" and that jute is sometimes prepared by the process of dew-retting. In this case it is evident that the description could have been made much more lucid and accurate if a separate paragraph had been devoted to each of the two fibres.

CHEMISTRY OF PULP AND PAPER-MAKING. By Edwin Sutermeister, S.B. Second Edition. Pp. x + 565,  $8\frac{1}{2} \times 5\frac{1}{2}$ . (New York : John Wiley & Sons, Inc. ; London : Chapman and Hall, Ltd., 1929.) Price 32s. 6d.

The first edition of this useful work appeared in 1920 and was reviewed in this BULLETIN (1921, 19, 258–259). For the purpose of the present edition portions of the book have been re-written and fresh material has been added.

The volume, which is intended for use by technical chemists and chemical engineers, can be recommended as a practical text-book on the subject.

**ÖLPALME.** By Prof. Dr. E. Fickendey and H. N. Blommendaal. Bangerts Auslandsbücherei, No. 35. Reihe: Wohltmann-Bücher Monographien zur Landwirtschaft warmer Länder, Band 7. Pp. vi + 211, 7 × 4 $\frac{3}{4}$ . (Hamburg and Leipzig: Deutscher Auslandsverlag Walter Bangert, 1929.) Price RM.9.

This book gives a comprehensive account of the cultivation of the oil-palm and the preparation of its products. It is divided into two parts, the first, written by Prof. Fickendey, being devoted to a consideration of the cultivation of the palm. A description of the tree is furnished together with details as to its habitat, its distribution, and its varieties. Then follows a section which occupies the greater portion of the first part of the book and supplies information on various questions involved in the establishment of a plantation, such as the kind of soil suitable, the climate desirable, the preparation of seed-beds, transplanting, manuring, intercalary cultivation, pollination and harvesting. Diseases and pests affecting the palm are also described.

H. N. Blommendaal is responsible for the compilation of the second part of the volume, which deals with the products of the palm and their preparation. After treating of the uses of the products and the trade in them, a description is given of the methods employed, with special reference to the Dutch East Indies, for the sterilisation of the fruits, the preparation of palm oil by expression, extraction and by centrifugal means, the purification of the crude oil, the cracking of the nuts, and the separation of the shell from the kernels. The properties of the products of the palm and the methods recommended for their examination are then considered, and the packing of palm oil is discussed, the respective merits of shipment in casks, drums and tanks being compared. Information regarding the methods of marketing palm oil and kernels is also provided.

**FRUIT PECTIN. ITS COMMERCIAL MANUFACTURE AND USES.** By William A. Rooker. Including a chapter on Patents on the Manufacture and Use of Pectin. By Milo R. Daughters. Pp. ix + 170, 7 $\frac{1}{4}$  × 5. (New York: Avi Publishing Co., Inc., 1928.) Price 26s.

This book is made up of a series of articles which were published at intervals, from 1925 to 1928, in the American

periodical, *The Fruit Products Journal*. It deals with the various processes employed in the preparation of liquid and powdered pectin, the relative merits of these two forms of the material, the evaluation of the raw material, the various uses of pectin, standards and definitions of preservers' products and the chemistry of jelly-making. Mr. Rooker's articles are concerned solely with apples as a source of pectin, but the chapter on patents deals also with those relating to lemons and oranges. It is pointed out that the total output of liquid and powdered pectin in the United States amounts to 2,000,000 lb. annually (calculated as dry material). Although its use in jellies, jams and marmalades still absorbs the bulk of the output, it is interesting to note that its employment in other confections, as an emulsifying agent, and for other purposes, shows signs of rapid growth, so that the prospects of the pectin industry appear to be extremely favourable.

Attention is now being devoted in a number of British countries to the preparation of pectin from citrus fruits and although the present work does not deal specifically with those fruits, it contains much information that will be useful to producers of such pectin as well as to those who employ apples as a source of the product.

AMERICAN SOAP MAKER'S GUIDE. By I. V. Stanley Stanislaus and P. B. Meerbott. Pp. xi + 709, 9½ × 6. (London : Chapman & Hall, Ltd., 1929.) Price 50s.

The first edition of this book appeared a generation ago under the title of *A Practical Treatise on the Manufacture of Soap and Candles*, and was succeeded in 1912 by a second edition known as *The Soapmaker's Handbook*. A continuously growing demand has compelled the publication of the present (third) edition, which has appeared with yet another title. This volume, while partly based on the previous editions, has been entirely re-written and has been modernised to meet the present trend of the industry. It bears the sub-title of "an up-to-date treatise on the art and science of the manufacture of soaps, candles and allied toilet preparations."

Of the twenty-nine chapters, ten are new and deal with a variety of subjects, such as the recovery of glycerine, the manufacture of candles, the art of perfuming with a description of the natural and artificial perfumes employed, the manufacture of toilet creams and lotions and dental preparations (including a large number of recipes), methods of testing raw materials, and a discussion of soaps from the physico-chemical point of view. Other chapters of

the book treat of the raw materials used in the industry and their preparation and, in the case of oils, their refinement. Information is given on the manufacture of the various kinds of soap and washing powders and on the methods employed for the testing of these products. The last chapter contains a number of useful tables.

THE PRACTICE OF SILVICULTURE. By Ralph C. Hawley. Second Edition. Pp. xiii + 335, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1929.) Price 20s.

The appearance of the second edition of this American work on silviculture affords an opportunity of referring to the general scope of the book since the new issue brings up-to-date one of the comparatively few works in English dealing with a subject which is now beginning to attract so much attention in English-speaking countries. In recent issues of this BULLETIN reference has been made to other important new works on the subject, particularly Troup's "Silvicultural Systems" (see this BULLETIN, 1928, 26, 527) and Toumey's "Foundations of Sylviculture upon an Ecological Basis" (*loc. cit.*, 1929, 27, 139). The present book makes no claim to originality; it is a useful compilation from available sources of information supplemented by the results of the author's own experience. The subject matter has been prepared and presented from the standpoint of the teacher of sylviculture, and the author lays stress on his contention that a somewhat "theoretical" treatment of sections of his subject is justified since his experience shows that sylvicultural methods as described in books must commonly be so modified and adapted to local conditions when applied in practice as to be scarcely recognisable. This position will be readily conceded, for as in other fields of work the so-called "theoretical" statement is the invaluable "normal" which it is the art of the experienced worker to adapt to varying local circumstances.

The book opens, after a preliminary chapter, with a description of the different methods of forest reproduction and the treatment of the stand during the period of regeneration or establishment. The methods dealt with are those of clear cutting, seed tree, shelterwood, selection coppice and coppice with standards. Intermediate cuttings are discussed in a series of chapters, followed by others on the disposal of the resulting waste or slash. A most important section of the book deals with forest protection and it is these chapters that the author has more especially modernised, notably as regards

developments connected with protection against fire and fire control, to which much attention has been given in the United States during the last ten years.

The book is primarily intended for American practice, but it can be read with advantage by all students of silviculture. It is remarkable in presenting no gallery of photographs such as is usual in books from the States, but the diagrams given are useful and practical.

THE FORESTS AND FORESTRY OF SUOMI, FINLAND. By N. A. Hilden, Forest Research Institute, Helsinki. Pp. 13, with photographs,  $5\frac{3}{4} \times 8\frac{3}{4}$ . (Helsinki: The Otava Publishing Co., 1929.)

This attractive booklet gives a brief but interesting account of the forests of Finland, the most richly wooded country in Europe. The principal trees in the forests are pine (*Pinus silvestris*) and spruce (*Picea excelsa*), though there are also deciduous trees of some importance, particularly birch (*Betula verrucosa* and *B. odorata*), aspen (*Populus tremula*), and alder (*Alnus incana*).

Figures are given showing the proportions of land under different species, and also the distribution of the forests among different forms of ownership (private, state, etc.) with their growing stocks and annual increments.

The forests constitute the principal part of the national wealth and are an important factor in the economic life of the Republic, forest products in the form of timber, plywood and pulp making up by far the greater proportion of the total exports. Great Britain is the largest buyer of timber from Finland. The booklet includes a number of excellent photographic illustrations showing different kinds of forest scenery and activities.

MANGROVE FORESTS OF THE MALAY PENINSULA. By J. G. Watson. Pp. viii + 275,  $10\frac{1}{4} \times 7$ . (Singapore: Fraser & Neave Ltd., 1928.) Price \$3.00 or 7s.

This publication, written by the Deputy Conservator of Forests, Federated Malay States, forms No. 6 of the Malayan Forest Records. It deals with the immense mangrove swamps which cover some 430 square miles of the Malay Peninsula and almost all of which occur on the West Coast. The volume opens with a general description of these forests and of their formation and topography; means of approach are discussed and information as to the inhabitants and health conditions is given, together with an enumeration of the animals

existing in the swamps. Two chapters are devoted to the consideration of the flora and to their botanical description. A list of the different species is given, the chief genera being *Rhizophora*, *Bruguiera*, *Ceriops*, *Kandelia*, *Sonneratia*, *Avicennia* and *Carapa*. A key is furnished whereby, with the assistance of the illustrations, leaf diagrams and botanical descriptions, the different species may be readily identified. The distribution of the various species, and the types of mangrove forests are discussed. The dangers to which the trees are exposed are outlined, the most serious enemies being crabs, whilst much damage is liable to be caused by floods.

The schemes adopted in the past for the management of the forests are reviewed, the methods recommended as a result of the experience gained are recorded, and indications are given of the yields to be expected. The utilisation of the swamps is discussed, each species and its uses being enumerated in tabular form. The main purposes for which the trees are exploited, namely, for firewood, timber and tanning materials, are considered. Reference is also made to the use of the nipah palm as a source of power alcohol. The last chapter, entitled "Exploitation," describes the system of subcoupes and their allotment and the methods in vogue for the working of the swamps for firewood and timber. The problem of transport of the products is touched on and the need of reorganisation of the present methods of exploitation is emphasised.

The book is illustrated with 72 plates which are excellently reproduced. The subject-matter is well arranged and a bibliography is provided. The volume forms a valuable addition to the literature dealing with the economic resources of Malaya.

AN INTRODUCTION TO THE CHEMISTRY OF PLANT PRODUCTS, VOL. II. METABOLIC PROCESSES. By Paul Haas, D.Sc., Ph.D., and T. G. Hill, D.Sc., A.R.C.S. Second edition. Pp. viii + 220,  $8\frac{1}{2} \times 5\frac{1}{2}$ . (London: Longmans, Green & Co., 1929.) Price 10s. 6d.

The previous edition of this volume appeared in 1922 and was noticed at the time in this BULLETIN (1922, 20, 558). Since then there have been further editions of Vol. I, the last of which is dealt with in this BULLETIN (1928, 26, 532). In the preface to the present edition of Vol. II the authors point out that "the expanding margin of botanical knowledge and the trend of botanical thought have made necessary much revision and rewriting," but that at the same time "the original intention of providing a

general introduction to the problem of plant metabolism " has been maintained. The new edition, like its predecessor, can be recommended as a well compiled and interesting text-book for students of vegetable physiology.

AFRICAN DISPENSARY HANDBOOK. By Clement C. Chesterman, O.B.E., M.D. (Lond.), M.R.C.P., D.T.M. and H. (Camb.). Pp. xii + 276,  $7\frac{1}{4} \times 4\frac{3}{4}$ . (London: The Christian Literature Society for India and Africa). Price 4s. 6d.

A MOTHERCRAFT MANUAL. By Edith R. and W. Millman, assisted by C. C. Chesterman, O.B.E., M.D. Pp. viii + 82,  $7\frac{1}{4} \times 5$ . (London: The Christian Literature Society for India and Africa, 1929.) Price 1s. 6d.

These are two clearly written, concise, illustrated handbooks, which can be strongly recommended to those concerned with the medical treatment of natives in Africa and other tropical countries. The first-named book is intended primarily as "an aid to the training and practice of African medical assistants and for the guidance of all engaged in medical practice in the dispensaries of Africa"; but it will undoubtedly be of use to many others as well, and is worth general perusal by Europeans and educated natives likely to be concerned with the study or treatment of diseases and injuries in the tropics. The second work, written "for senior girls and newly married women in Africa," is a short practical guide to the technicalities of midwifery and the treatment of young infants, and most of the information which it gives therefore applies equally to all parts of the world.

MINERALS IN PASTURES AND THEIR RELATION TO ANIMAL NUTRITION. By J. B. Orr, D.S.O., M.C., M.A., D.Sc., M.D., with the assistance of Helen Scherbatoff. Pp. xv + 150,  $9\frac{3}{4} \times 6$ . (London: H. K. Lewis & Co., Ltd., 1929.) Price 10s. 6d.

This useful work has been compiled at the request of a Sub-Committee appointed in 1926 by the Civil Research Committee of the Cabinet to consider and report on the relationship between the mineral constituents of pastures and their nutritive value. The subject is one of great economic interest. As pointed out by Prof. E. P. Cathcart, F.R.S., in a foreword to the volume, it has long been known that various inorganic constituents of pastures, such as calcium, phosphorus, iron and iodine, are essential for the life of the grazing animal, and the presence of an adequate quantity of such constituents must therefore be

ensured. It is not always realised that the export from a pastoral area of animal products (such as milk, meat, hides and bones) eventually results, unless compensated for by special means, in the reduction to a dangerous level of the quantities of mineral constituents in the pastures concerned; since these substances (unlike hydrogen, oxygen, carbon and nitrogen) cannot be obtained in appreciable quantity from rain or the atmosphere.

Dr. Orr, who is the Director of the Rowett Research Institute at Aberdeen, points out in his Introduction that the deficiency of given areas in these necessary constituents is now being investigated by veterinarians, whose interest is the effect of the deficiencies on the grazing animal, and also by agronomists who are interested in the wider general problems of pasture husbandry. In the present volume an attempt is made "to bring together the available information likely to be of use to those engaged in this work." It is not possible in a short notice to make any adequate summary of the data presented by Dr. Orr, but it may be useful to mention that the information is arranged mainly under the headings of "The Mineral Content of Pastures"; "Factors affecting the Mineral Content of Pastures"; "Conditions under which Diseases due to Deficiency of Minerals in Pastures Occur"; "Deficiency Diseases in Grazing Animals" (with sub-divisions for the various Continents); and "Effect of Mineral Intake on Rate of Production of Grazing Animals." For the purpose of his work Dr. Orr has carried out a detailed search of the literature of the subject. Copious bibliographies are provided, and the volume can be strongly recommended to all agriculturists concerned with pasture lands or the raising of animals upon them.

THEORY AND PRACTICE IN THE USE OF FERTILISERS. By Firman E. Bear, Ph.D. Pp. vii + 348, 9 x 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1929.) Price 20s.

The number of books on fertilisers seems to grow at such a rate that it is not always easy to say of any one that it is more to be recommended than another. A particular feature of the present publication is the method of approach to the subject from its historical beginnings, starting from the early discoverers and writers, following up subsequent lines of investigation, and leading up to the modern practice of fertilisation. At the beginning of each chapter is a photograph of one of the principal pioneers in the science or contributors to its advancement.

The book is one for students who aim at a fundamental understanding of the part played by fertilisation in agriculture, and who realise that this cannot be acquired without a fuller knowledge of its theoretical basis than is to be derived from the strictly utilitarian reading of the purely practical man.

LES RICHESSES MINIÈRES DE LA NOUVELLE ROUMANIE.  
By Aurel P. Iancoulesco. Pp. 380, 10 × 6½: (Paris : Librairie Universitaire J. Gamber, 1928.)

This is a very interesting and informative work on the mineral resources of Rumania.

It is divided into four parts. The first portion describes the topography, climate, fauna, etc., and includes a précis of the history of the country.

The second part is devoted to petroleum. The industry is very fully dealt with in about 130 pages of text. The Rumanian production of crude petroleum has shown a continuous increase in recent years, and now amounts to upwards of 4¼ million metric tons, whereby that country occupies the sixth place among the world's producers. The oil occurs in the Tertiary formations, being most abundant in the Pliocene.

According to the Rumanian mining law, the personnel of any concession, etc., must consist of at least 75 per cent. of Rumanian workers. As a matter of fact, the percentage of natives working the mines, wells, etc., is generally much higher than this. Thus in 1926, the personnel of the petroleum industry amounted to 32,323, of which only 369 were foreigners.

The third section describes Rumanian coal, natural gas, mineral springs, gold, silver, copper, iron, salt and other minerals, and quarries.

The amber of Buzau is said to be superior in beauty to that of any other known amber, but it occurs at some depth from the surface, and is therefore more costly to exploit than, for example, such surface deposits as those of Danzig. The best amber, known as "sidef" (mother of pearl), is used for making cigarette holders and other articles of luxury. One company, "Ambra," is working the mineral, and produced 130 kilograms in 1924, but the Rumanian production in that year was greater than this. Statistics are incomplete, owing to the primitive methods used in working. The author is of opinion that if the amber were mined by modern methods, the mineral would yield large profits.

The gold and silver mines of Transylvania were mentioned by Herodotus, and were worked by the Romans

by means of galleries to a maximum depth from surface of nearly 1,000 feet. The present annual production of gold amounts to from about 40,000 to 65,000 ounces, and of silver to from 76,000 to 140,000 ounces.

Copper ore occurs in Dobroudgea, the Banat and Transylvania, but the present output only amounts to some 200 tons per annum.

The principal pyrites deposits are those of Maramuresch, which contain from 37 to 45 per cent. of sulphur, and from 0.7 to 2.25 per cent. of copper. The Rumanian output of pyrites in 1926 amounted to 42,000 metric tons, but dropped to about 25,000 tons in 1927.

The known deposits of manganese are small, and the annual production amounts only to from 5,000 to 10,000 metric tons.

Chromite occurs at Dubova, in the Banat, and was worked by the Germans during the Great War, but the ore is low grade, and is not being won at present.

In 1905, considerable deposits of bauxite were discovered in the Bihar mountains. The visible and probable reserves are said to be 26,000,000 tons. The author is of opinion that, by utilising the waterfalls of the country, a big aluminium industry might be developed locally.

There are small deposits of both lead and zinc ores in Rumania, but they have not yet been exploited.

Since 1924, the "Aurifera" company has worked cinnabar at Vatea Dosului, in the Alba district, the mineral being reduced on the concession. In 1926, the production of quicksilver amounted to 2,026 kilograms, but was nearly double this in 1925 and 1927.

Phosphorite has been discovered in Lincautzi, in northern Bessarabia, but the deposits have not yet been studied.

Important deposits of mica occur at Voineasa, in the Lotru valley. They are said to be the largest deposits in the world, and better than the Indian mineral, but, unfortunately, they are situated on high mountains inaccessible to railways.

Asphalt rock is being worked in two places, the output of which has increased from about 13,000 metric tons in 1922 to 24,891 tons in 1926.

Iron-ore deposits are being worked in Transylvania and in the Banat. In the former the ore is limonite, with siderite in depth, and, in the latter, magnetite and hæmatite. There are seven blast furnaces in the country, and the annual production of pig-iron amounts to upwards of 62,000 metric tons per annum.

Rumania is bountifully supplied with salt. Rock salt occurs in large masses, and, in addition, there are twelve saline lakes, and one thousand saline springs. The reserves of three of the rock-salt masses in Old Rumania are estimated at 8,000,000,000 metric tons.

One mass in Transylvania is 900 metres long, 550 metres wide, and upwards of 200 metres in thickness. The Rumanian production in 1926 amounted to 344,062 metric tons.

Rumania possesses numerous medicinal lakes and springs, many of which are of European fame, as those of Baile Herculane—resorted to by the Roman aristocrats and legionaries—the radioactivity of which is said to be nearly the same as that of the waters of Vichy and Mont-Dore; Lake Tekirghiol, the bottom of which contains a thick sediment or mud having wonderful therapeutic properties; lakes Budachi and Tuzla, in Bessarabia, and lakes Lacul Sarat, Balta Alba and Amara in the basin of the Danube. All the above belong to the State. Other well-known medicinal springs are those of Govora, Calimanesti, Căciulata, Olăneshti and Sarata-Monteoru. The radioactivity of Căciulata is said to surpass that of the waters of Vichy and Frantzensbad.

The fourth part of the work treats especially of the Rumanian mining law of July 3, 1924. This has been superseded by a new mining law, which was passed in March 1929.

The book concludes with a useful bibliography.

INDUSTRIAL CARBON. By C. L. Mantell, Ph.D. Pp. ix + 410,  $8\frac{3}{4} \times 5\frac{3}{4}$ . (London: Chapman & Hall, Ltd.) Price 21s.

The literature dealing with carbon and its uses has hitherto been scattered and somewhat laborious to collect, and the present volume is a very useful compilation and summary of the available information on the subject.

It deals very comprehensively with the preparation of carbon, in its elemental and allotropic forms, for industrial and technical purposes, and gives clear descriptions of the many ways in which it is now utilised.

The subjects are dealt with in 29 chapters, which include, amongst others, descriptions of the use of carbon in the manufacture of crucibles, lubricants and pigments; for gas absorption and for decolorising purposes; and for the production of electrodes, battery carbons and pencils.

The book, which is one of the Industrial Chemical Monographs of the Van Nostrand Co. of America, is well produced. It has good subject and author indexes, and a list of references to other literature, and should prove of much value to those interested in this ubiquitous material.

CHEMICAL ENGINEERING AND CHEMICAL CATALOGUE.  
Edited by D. M. Newitt, Ph.D., B.Sc., D.I.C., A.R.C.S.,  
A.I.C., A.I.Chem.E. Fifth Edition. Pp. 401, 11 × 8½.  
(London : Leonard Hill Ltd., 1929.) Price 15s.

This publication includes catalogues of chemical products and of plant and equipment ; a classified index of chemicals and plant ; a short list of trade marks and names ; an index of industrial applications of chemicals and plant ; a section of technical tables and data ; and a list of technical books, classified under subjects and authors.

The book seems to suffer, to some extent, from an attempt to cover too much ground, and a concentration on, and extension of, certain portions would appear advantageous.

The most useful section appears to be the classified index of chemicals and plant, and an enlargement of this part, to include as many items and firms as possible, would increase its value.

Two examples may be mentioned of omissions in this section, viz., abrasives, and polishing materials, and others could be quoted.

The advisability of including a section of technical tables, which can mainly be found in more specialised treatises, in a book of this nature, is very doubtful as few people would be likely to refer to it for such data as logarithms and atomic weights. Analytical data, such as are found on page 337, could also be well left to textbooks on analytical chemistry.

The technical and scientific book section is useful, but is by no means exhaustive. One looks in vain, for example, for such well-known authors as Mellor, and Treadwell and Hall under analytical chemistry, and only one author reference is given to each of such subjects as lignites, rocks and shales.

The fact that this publication has reached a fifth edition is a sufficient indication that it meets a demand, and amplification and curtailment in the directions suggested above would appear to be likely to increase further its practical value.

CATALOGUE OF LEWIS'S MEDICAL AND SCIENTIFIC CIRCULATING LIBRARY. Part I.—Authors and Titles. Part II.—Classified Index of Subjects, with names of Authors who have written upon them. New edition. Revised to the end of 1927. (London: H. K. Lewis & Co. Ltd., 1928.) Price 15s. net.

This catalogue should be of considerable use to scientific authors, investigators and students, and to medical men, not only as a general index to Messrs. H. K. Lewis and Co.'s well-known library of medical and scientific works but also as a comprehensive list of such works for general reference. As stated, the items are arranged in two alphabetical lists, viz. under the names of authors and under subjects, and as an indication of the scope of the catalogue it may be mentioned that the first of these sections covers over 400 pages.

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#### BOOKS RECEIVED FOR NOTICE

GLUE AND GELATINE. By Paul I. Smith. Pp. x + 162,  $8\frac{1}{2} \times 5\frac{1}{2}$ . (London: Sir Isaac Pitman & Sons, Ltd., 1929.) Price 8s. 6d.

STRUCTURE AND SURFACE. A BOOK OF FIELD GEOLOGY. By C. Barrington Brown, M.C., M.A., A.R.S.M., F.G.S., and F. Debenham, O.B.E., M.A., F.G.S. Pp. vii + 168,  $9 \times 5\frac{3}{4}$ . (London: Edward Arnold & Co., 1929.) Price 10s. 6d.

THE NAPPE THEORY IN THE ALPS. By Dr. Franz Heritsch, translated by P. G. H. Boswell. Pp. xxx + 228,  $7\frac{1}{2} \times 4\frac{3}{4}$ . (London: Methuen & Co., Ltd., 1929.) Price 14s.

SOME PROBLEMS OF INDIAN METEOROLOGY, being the Halley Lecture delivered on May 31, 1929, by Sir Gilbert Thomas Walker. Pp. 23,  $9 \times 6$ . (Oxford: The Clarendon Press; London: Mr. Humphrey Milford, Oxford University Press, 1929.) Price 2s. 6d.

SURVEYING AS PRACTISED BY CIVIL ENGINEERS AND SURVEYORS. By John Whitelaw, Jun. Eighth Edition, thoroughly revised and enlarged by Colonel Sir Gordon Risley Hearn, C.I.E., D.S.O. Pp. xv + 578,  $8 \times 5$ . (London: Crosby Lockwood & Son, 1929.) Price 16s.

# REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

*Selected from the Reports made to the Dominion, Colonial  
and Indian Governments*

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## THE COMPOSITION OF SISAL HEMP FROM DIFFERENT COUNTRIES

A STUDY has been made at the Imperial Institute of the chemical composition and behaviour of a large number of samples of Sisal hemp, characteristic of the produce of different countries, viz. Tanganyika, Kenya, Portuguese East Africa and Mexico.

The samples were representative of ordinary commercial shipments, most of them being kindly supplied by the following firms: Messrs. Wigglesworth and Co., Ltd., Messrs. Craven and Speeding Bros., Ltd., Messrs. Hood, Haggie and Son, Ltd., and Messrs. E. W. Walker and Co.

### DESCRIPTION OF THE SAMPLES

#### A. *Samples from Tanganyika, Nos. 1-9*

No. 1. *Tanganyika Sisal No. 1 Grade*.—Clean, well prepared, lustrous fibre, very pale cream in colour. The strands varied in length from  $3\frac{1}{2}$  to 5 ft., being mostly about 4 ft. Strength, good.

No. 2. *Tanganyika Sisal No. 2 Grade*.—Fibre similar to No. 1 in cleanness and preparation, but very slightly darker in colour. The length varied from 2 to  $3\frac{1}{2}$  ft., being mostly about 3 ft. Strength, good.

No. 3.—Clean, fairly fine, lustrous, well prepared fibre, of pale cream colour. The length varied from 4 to 5 ft., being mostly  $4\frac{1}{2}$  ft. Strength, good.

No. 4.—Similar to No. 3, but somewhat finer and slightly paler. The length varied from  $3\frac{1}{4}$  to 4 ft., being mostly  $3\frac{3}{4}$  ft. Strength, good.

No. 5.—Similar to No. 3, but slightly more lustrous. The length varied from  $3\frac{1}{2}$  to 5 ft., being mostly 4 ft. Strength, good.

No. 6.—Generally similar to No. 3. The length varied from  $3\frac{1}{4}$  to 4 ft., being mostly  $3\frac{3}{4}$  ft. Strength, good.

No. 7. *Unbrushed No. 1 East African Sisal, Kakuzi Estate.*—Clean, fine, lustrous, pale cream-coloured fibre, varying in length from  $3\frac{3}{4}$  to  $4\frac{1}{2}$  ft., being mostly about 4 ft. Strength, good.

No. 8. *Unbrushed No. 1 East African Sisal, Kituamba Estate.*—Clean, fine, lustrous, pale cream-coloured fibre, varying in length from 4 to  $4\frac{1}{2}$  ft., being mostly about 4 ft. Strength, good.

No. 9. *Unbrushed No. 1 East African Sisal, Kitito Estate.*—Clean, fine, lustrous, very pale cream-coloured fibre, varying in length from 4 to  $4\frac{1}{2}$  ft., being mostly about 4 ft. Strength, good.

#### B. Samples from Kenya, Nos. 10–13

No. 10.—Clean, well prepared, fairly fine and lustrous, cream-coloured fibre. The length varied from  $3\frac{3}{4}$  to  $4\frac{1}{2}$  ft., being mostly  $4\frac{1}{4}$  ft. Strength, good.

No. 11.—Similar to No. 10. The length varied from  $2\frac{1}{2}$  to 4 ft., being mostly  $3\frac{1}{2}$  ft. Strength, good.

No. 12.—Clean, well prepared, lustrous fibre, of very pale colour. The length varied from  $3\frac{1}{2}$  to  $4\frac{1}{2}$  ft., being mostly  $3\frac{1}{2}$  ft. Strength, good.

No. 13.—Very clean fibre, lustrous and almost white. The length varied from 3 to 4 ft., being mostly  $3\frac{1}{2}$  ft. Strength, good.

#### C. Samples from Portuguese East Africa, Nos. 14–17

No. 14.—Clean, well prepared, fairly lustrous, cream-coloured fibre. The length varied from  $2\frac{1}{2}$  to 4 ft., being mostly  $2\frac{1}{2}$  ft. Strength, good.

No. 15.—Similar to No. 14. The length varied from 2 to 3 ft., being mostly  $2\frac{1}{2}$  ft. Strength, good.

No. 16.—Fairly well prepared, cream-coloured fibre, rather harsher than samples Nos. 14 and 15 and of fair lustre. A somewhat large amount of pulpy matter was

adhering to the strands. The length varied from 3 to 4 ft., being mostly  $3\frac{1}{2}$  ft. Strength, good.

No. 17.—Similar to No. 16. The length varied from 2 to 3 ft., being mostly  $2\frac{1}{2}$  ft. Strength, good.

D. *Samples from Mexico, Nos. 18–27*

No. 18. *Mexican Sisal, Good White*.—Fairly clean, moderately lustrous fibre, pale cream to dark cream in colour. Some pulpy matter was adhering to the fibre strands, and small reddish-brown specks of epidermal matter were present throughout the length of the fibre, causing discoloration. The fibre varied in length from  $3\frac{3}{4}$  to  $4\frac{1}{2}$  ft., being mostly about 4 ft. Strength, good.

No. 19. *Mexican Sisal, Good White*.—Pale yellowish-brown fibre, rather lacking in lustre, somewhat coarser than sample No. 18. Rather more pulpy matter was present in this sample, which was also spotted in places with reddish-brown stains. The fibre was much inferior in appearance to No. 18. The length varied from  $3\frac{1}{2}$  to  $4\frac{1}{2}$  ft., being mostly about 4 ft. Strength, good.

No. 20. *Mexican Sisal*.—Fairly well prepared, but poorly cleaned. The fibre was fairly lustrous, but mostly of a pale greenish tint owing to imperfect washing. A good deal of pulpy matter was adhering to the strands. The length of the fibre varied from 3 to 4 ft., with an average of about  $3\frac{1}{2}$  ft. Strength irregular, on the whole rather weak.

No. 21. *Mexican Sisal*.—Clean, well prepared, fairly lustrous and of a pale cream colour. The length of the fibre varied from 3 to 4 ft., with an average of about  $3\frac{1}{2}$  ft. Strength, good.

No. 22. "*Especial*" *Mexican Sisal*.—Clean, well prepared, pale cream-coloured, lustrous fibre, with a few reddish-brown stains on some of the strands. The length varied from 3 to  $3\frac{1}{2}$  ft., being mostly  $3\frac{1}{4}$  ft. Strength, good.

No. 23. *Good White Mexican Sisal (A)*.—Similar to No. 22 but somewhat darker in colour. The length varied from 3 to  $3\frac{1}{2}$  ft., most of the fibres being about  $3\frac{1}{4}$  ft. Strength, good.

No. 24. *Good White Mexican Sisal (B)*.—Fibre of slightly darker colour than No. 23. Some pulpy matter

adhered to the strands, and reddish-brown specks of epidermal matter were present in places. The length varied from 3 to  $3\frac{1}{2}$  ft., being mostly about  $3\frac{1}{2}$  ft. Strength, fairly good.

No. 25. *Red Mexican Sisal*.—A mixture of strands of different colours, ranging from dark cream to reddish-brown. Dark reddish-brown epidermal matter was present in places, often causing a number of fibres to be matted together. The fibre contained a good deal of pulpy matter and was generally of inferior appearance. Its length varied from 3 to  $3\frac{3}{4}$  ft., being mostly  $3\frac{1}{2}$  ft. Strength, variable, in part fairly good.

No. 26. "*Especial*" *Brushed*.—Clean, well prepared, very lustrous fibre, mainly cream to white in colour, but showing slight greenness towards the butt ends. Small dark specks of epidermal tissue were observed throughout the length of the fibre, and a small amount of pulpy matter was present. The length varied from 3 to 4 ft., with an average of about  $3\frac{1}{2}$  ft. Strength, good.

No. 27. "*Especial*."—Slightly inferior in colour, lustre and appearance to sample No. 26. The fibre had not been adequately freed from pulpy matter. The length varied from  $2\frac{3}{4}$  to 4 ft., with an average of about  $3\frac{1}{2}$  ft. Strength, good.

#### METHODS OF INVESTIGATION

The methods employed in the chemical examination of these fibres are based on those described by Cross and Bevan (*Report on Indian Fibres and Fibrous Substances*). The following is a summary of the processes adopted, together with an indication of the manner in which the results are interpreted.

*Moisture*.—The amount of moisture is determined by drying a specimen at 100–110° C. It is to some extent an index of the susceptibility of the fibre to attack by hydrolytic agents. Textile fibres of the highest class are distinguished by their relatively low moisture content. Owing to the variation of this constituent (1 to 2 per cent.) with changes in the hygroscopic state of the atmosphere, all the other results of analysis are expressed as percentages of the moisture-free fibre.

*Ash.*—The percentage of ash is determined by completely incinerating the fibre and weighing the residue. An abnormally large percentage of ash usually indicates the presence of mineral impurity introduced during the preparation of the fibre.

*$\alpha$ -Hydrolysis.*—The fibre is immersed in boiling dilute solution of sodium hydroxide (1 per cent.  $\text{Na}_2\text{O}$ ) and the boiling continued under a reflux condenser for five minutes. The fibre is then washed free from alkali, dried and weighed. The loss in weight indicates the amount of substance removed by the solvent action of the alkali.

*$\beta$ -Hydrolysis.*—Another portion of the fibre is boiled for one hour under a reflux condenser with alkali of the same strength. In this case, the loss in weight includes not only the substance removed by the solvent action, but also that rendered soluble by the "degrading" action of the alkali. It is evident, therefore, that the difference between the values obtained on  $\alpha$ - and  $\beta$ -hydrolysis indicates the susceptibility of the actual fibre substance to attack by hot, dilute, caustic alkali.

The results yielded by these determinations afford an indication of the ability of the fibre to resist prolonged exposure to moisture and the attack of alkaline liquids with which the fibre may be treated during the processes of manufacture.

*Acid Purification.*—The fibre is put into acetic acid (20 per cent. solution), which is slowly heated until it boils; the fibre is removed, washed first with alcohol and afterwards with water, and then dried and weighed. The loss in weight is chiefly due to the removal of casual impurities.

*Water Washing.*—The fibre is placed in 500 c.c. of distilled water. The water is then heated slowly until it boils, the fibre meanwhile being frequently agitated. The boiling water is then decanted, and the process repeated with a further quantity of water. The fibre is finally dried and weighed.

*Cellulose.*—The fibre is boiled for five minutes with a solution of dilute sodium hydroxide (1 per cent.  $\text{Na}_2\text{O}$ ), is washed free from alkali, and, while still moist, is exposed to the action of chlorine gas for one hour; in some cases,

a longer exposure is necessary. It is then washed and treated with a 3 per cent. sodium sulphite solution, which is slowly heated until it boils ; after two or three minutes' boiling a small quantity of cold water is added and the flask is then corked and shaken gently at first, and afterwards violently, in order to break up the fibre into its ultimate elements. The product is collected on a calico filter and washed ; it is afterwards treated with acetic acid (20 per cent. solution) and again washed, dried and weighed.

When the chlorinated fibre is immersed in the sodium sulphite solution, a brilliant purple or crimson coloration is produced if the fibre belongs to the lignocellulose type, whilst in the case of non-lignified fibres the solution remains practically colourless.

In this method of determining the percentage of cellulose, the non-cellulose substance is rendered soluble and removed, whilst the true cellulose is not attacked. The percentage of true cellulose in a fibre is the most important criterion of its composition and value.

#### RESULTS OF EXAMINATION

Representative portions of the samples were submitted to examination in accordance with the methods outlined above and the results are given in the tables on pages 447-448.

#### REMARKS

*Samples from Tanganyika.*—These samples all contained high percentages of cellulose and in general gave very similar results. Sample No. 2 appeared to have been unusually well washed in the course of its preparation as it sustained a loss of only 0.2 per cent. on water washing, and this is reflected in the low hydrolysis figures and the exceptionally high percentage of cellulose.

*Samples from Kenya.*—These four samples had not been quite so well washed as those from Tanganyika as they suffered somewhat greater losses on water washing and acid purification. This fact accounts for the rather higher losses on hydrolysis and the lower percentage of cellulose.

*Samples from Portuguese East Africa.*—The observa-

SAMPLES FROM TANGANYIKA

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	No. 9.	Average.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Moisture . . . . .	7.4				9.3	9.5	9.4	9.7	9.4	9.4
Calculated on moisture-free material :										
Ash . . . . .	0.7	0.7	0.5	1.0	0.8	0.9	0.5	0.8	0.6	0.7
Loss on $\alpha$ -Hydrolysis . . . . .	10.4	9.5	10.2	10.2	11.6	11.3	10.75	10.1	9.65	10.4
" " $\beta$ -Hydrolysis . . . . .	13.3	11.2	12.3	14.0	14.4	14.0	12.75	12.1	11.0	12.9
" " Acid purification . . . . .	2.9	1.1	1.2	1.8	3.0	2.8	1.8	1.85	1.2	2.0
" " Water washing . . . . .	2.4	0.2	1.0	1.3	2.2	2.3	1.35	1.5	0.9	1.5
Cellulose . . . . .	79.7	81.4	79.8	79.1	77.0	77.1	78.6	78.35	78.9	78.9

SAMPLES FROM PORTUGUESE EAST AFRICA

	No. 10.	No. 11.	No. 12.	No. 13.	Average.	No. 14.	No. 15.	No. 16.	No. 17.	Average.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Moisture . . . . .	9.3	9.4	9.9	10.1	9.7	9.1	9.0	9.6	9.4	9.3
Calculated on moisture-free material :										
Ash . . . . .	1.2	1.0	1.2	1.3	1.2	0.6	0.7	0.6	0.6	0.6
Loss on $\alpha$ -Hydrolysis . . . . .	11.3	10.9	10.8	11.6	11.2	12.2	13.2	10.3	12.5	12.1
" " $\beta$ -Hydrolysis . . . . .	13.0	13.5	12.9	13.4	13.2	14.7	15.0	15.3	15.9	15.2
" " Acid purification . . . . .	2.7	3.2	2.7	3.2	2.8	3.8	4.1	2.2	2.0	3.0
" " Water washing . . . . .	2.0	2.6	2.4	2.8	2.5	3.3	3.1	1.5	2.0	2.5
Cellulose . . . . .	77.4	76.3	78.0	77.5	77.3	77.3	76.3	75.6	76.0	76.3

SAMPLES FROM MEXICO

	No. 18.	No. 19.	No. 20.	No. 21.	No. 22.	No. 23.	No. 24.	No. 25.	No. 26.	No. 27.	Average.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Moisture	9.1	9.0	8.2	10.1	8.1	8.4	8.5	9.6	9.3	9.7	9.0
Calculated on moisture-free material:											
Ash	0.8	1.2	0.8	1.7	0.5	0.6	1.1	1.0	1.0	0.9	1.0
Loss on $\alpha$ -Hydrolysis	14.2	17.1	18.6	15.3	10.6	13.0	16.7	20.1	13.5	15.6	15.5
" " $\beta$ -Hydrolysis	19.8	19.9	21.8	19.1	12.8	15.4	18.7	22.3	16.7	17.2	18.4
" " Acid purification	4.9	10.1	9.9	6.4	1.7	2.0	9.1	11.4	3.6	6.3	6.5
" " Water washing	4.7	8.9	8.2	6.1	1.6	1.4	8.7	11.0	3.35	5.9	6.0
Cellulose	73.2	70.6	72.3	72.0	77.1	76.0	71.4	69.1	75.2	74.0	73.1

tions made regarding the Kenya samples are equally applicable in this case.

*Samples from Mexico.*—

The losses sustained by these samples show that the amount of washing to which they had been subjected in the course of preparation had varied greatly. In the case of Nos. 22 and 23 the washing had evidently been efficiently performed as the losses sustained on further washing amounted to only 1.6 and 1.4 per cent. respectively. On the other hand, some samples, such as Nos. 19, 20, 24 and 25, suffered large losses on washing, the loss in the case of No. 25 amounting to as much as 11 per cent. This variation in the amount of soluble impurity remaining in the fibre is reflected in the hydrolysis and acid purification figures and also in the percentages of cellulose present.

*General.*—It will be observed from the average results for the samples from East Africa that the Tanganyika samples underwent the smallest losses on hydrolysis, water washing and acid purification, and contained the largest proportion of cellulose. The Kenya samples were intermediate in all these respects between the Tan-

ganyika and Portuguese East Africa series. As already pointed out, the Mexican samples are mostly inferior to the East African owing to the large amount of soluble impurity present and the correspondingly low percentage of cellulose.

As pointed out on page 445, the difference between the values obtained on  $\alpha$ - and  $\beta$ -hydrolysis indicates the susceptibility of the actual fibre substance to attack by hot, dilute caustic alkali. It may also be regarded as an index of the relative stability of the fibre substance and consequently of its durability on exposure. It is therefore of interest to compare the constant (loss on  $\beta$ -hydrolysis — loss on  $\alpha$ -hydrolysis) in the case of the four classes of Sisal examined. The figures are as follows: Tanganyika samples, range 1.7–3.8, average 2.5; Kenya samples, range 1.7–2.6, average 2.0; Portuguese East Africa samples, range 1.8–5.0, average 3.1; Mexican samples, 1.6–5.6, average 2.9. It therefore seems evident that there is little, if any, actual difference between the stability of the fibre substance of the East African Sisal and that of the Mexican fibre.

### *EUCALYPTUS SALIGNA* AS A SOURCE OF WOOD PULP FOR PAPER AND ARTIFICIAL SILK

A SAMPLE of the wood of *Eucalyptus saligna* grown in Zululand was recently submitted to the Imperial Institute to ascertain its value for the production of pulp for industrial use.

The specimen of wood, which was stated to be from a six-year-old tree, consisted of a portion of the trunk, 5 in. in diameter, from which the bark had been removed. The colour varied from almost white in the sapwood to a pale pink tint in the heart-wood. The wood was fairly soft, rather coarse-grained, and contained a large number of hard knots.

A representative portion of the material was submitted to chemical examination with the following results:

	Per cent.
Moisture . . . . .	9.3
Ash . . . . .	0.5
Cellulose in wood as received . . . . .	55.9
„ expressed on the moisture-free wood	62.6

The ultimate fibres were found to have the following dimensions :

	Length in mms.	Diameter in mms.
Maximum . . . .	2.1	0.033
Minimum . . . .	0.8	0.0102
Average . . . .	1.4	0.0163

The chipped wood was submitted to treatment with caustic soda, under conditions similar to those employed commercially for the production of paper pulp by the soda process, with the following results :

Caustic soda used.		Conditions of digestion.		Parts of caustic soda consumed per 100 parts of wood.	Yield of dry pulp expressed on the wood as received.	
Parts per 100 parts of wood.	Parts per 100 parts of solution.	Time.	Temp.		Unbleached.	Bleached.
		hrs.	° C.		Per cent.	Per cent.
20	3	5	160	12.7	55	50

Under the conditions of treatment employed, a well digested pulp was obtained which furnished a fairly soft, opaque, pale brown paper of good strength. A small quantity of imperfectly reduced material was present, due most probably to the knotty nature of the wood. The pulp bleached with some difficulty to a cream colour, and then furnished a paper of similar strength and character to that from the unbleached pulp.

The above results show that this *E. saligna* wood from a six-year-old tree furnishes an excellent yield of pulp under comparatively mild treatment with caustic soda, and produces a fairly soft, opaque paper of good strength. The pulp somewhat resembled commercial poplar pulp, but was composed of rather longer fibres (averaging 1.4 mm. as compared with 1.0 mm.), and the paper was stronger than that furnished by poplar pulp. Unlike the latter, however, it required a strong bleaching solution to bleach it to even a moderately pale colour, and it might consequently not be suitable for use in the production of the higher grades of printing papers.

The wood was also tested to determine its suitability for artificial silk manufacture. The unbleached pulp obtained in the paper-making trial was treated with a quantity of standard bleaching powder equivalent to

20 per cent. of the original weight of the wood. The bleached pulp was then immersed in dilute sodium sulphite solution (2 per cent.) for a short period, in order to remove any free chlorine present and to improve the colour of the pulp by dissolving any lignin not removed by the bleaching treatment. The pulp was then thoroughly washed, treated with cold 1 per cent. hydrochloric acid to remove insoluble calcium salts, and finally freed from acid with distilled water, pressed and air-dried. The bleached pulp thus obtained was somewhat superior in colour and appearance to that produced in the paper-making trial.

The yield of dry bleached pulp, calculated on the original wood, was 42 per cent. On chemical examination the pulp gave the following figures, which are shown in comparison with those recorded for bleached sulphite pulp regarded as suitable for the manufacture of artificial silk and with the figures supplied by a large firm of artificial silk manufacturers for the wood pulp regularly in use in their factory :

—	Present sample.	Figures recorded for bleached sulphite pulp.		Manufacturers' figures.
		Hottenroth. <sup>1</sup>	Reinthal. <sup>2</sup>	
Moisture . . . per cent.	8.2	8 to 12	10	—
Calculated on the moisture-free material:				
Ash . . . per cent.	0.33	0.15 to 0.3	0.1 to 0.4	0.17
$\alpha$ -Cellulose . . per cent.	85.0	85 to 90	86 to 89	89.63
$\beta$ -Cellulose . . per cent.	10.2	} 11 to 14 {	6 to 8	3.69
$\gamma$ -Cellulose . . per cent.	4.8		3 to 5	6.63
Copper number . .	2.04	2 to 3	2 to 3	2.47
Phloroglucinol absorption value . . . .	1.6	—	—	1.03
Soda absorption value . .	2.09	—	—	1.62
Acetone extract per cent.	0.46	0.6 to 0.7	—	—

<sup>1</sup> "Artificial Silk," translated by E. Fyleman, London, 1928.

<sup>2</sup> "Artificial Silk," translated by F. M. Rowe, London, 1928.

These results show that the *E. saligna* pulp as prepared at the Imperial Institute contained a rather low percentage of  $\alpha$ -cellulose, whilst the figures for  $\beta$ -cellulose, ash, and phloroglucinol absorption value are somewhat higher than those usually regarded as satisfactory for pulp intended for artificial silk production.

It is probable, however, that by submitting the wood to a rather more drastic treatment the  $\alpha$ -cellulose could be increased and the  $\beta$ -cellulose and phloroglucinol absorption value reduced to satisfactory proportions. This treatment would somewhat reduce the yield of pulp. Whether such pulp would possess the necessary properties for conversion into artificial silk could only be determined by actual manufacturing trials.

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### THE TANNING VALUE OF *ANOGEISSUS* *LATIFOLIA* LEAVES

*Anogeissus latifolia* Wall. is a large deciduous tree, known as "Dhawa," which occurs in the Sub-Himalayan tract from the Ravi eastward and also in Central and Southern India. The leaves and twigs of this tree are used locally as a tanning material under the name of "Country Sumac," but do not appear to be employed at the present time in any tanneries run on modern lines in India. In view of the promising nature of the material, the Advisory Committee on Tanning Materials of the Imperial Institute suggested that a supply should be obtained for detailed examination in order to determine its suitability for use as a tanning material in the United Kingdom. A supply of the leaves was subsequently received for examination at the Imperial Institute, from the Forest Range Officer, Madura, Madras, through the agency of the Forest Research Institute, Dehra Dun.

It was pointed out that in the past great difficulty had been experienced in preparing the leaves on a commercial scale. It was considered necessary to dry the leaves in the shade in order to obtain material of the best quality and this could only be done with considerable trouble, since the leaves ferment rapidly with consequent loss of tannin. Owing to this difficulty of drying, the collection of the leaves, which had been undertaken by the Forest Department in Madras in 1918, had to be abandoned.

The samples of *A. latifolia* leaves received at the Imperial Institute were as follows :

*Sample A.*—Pale brownish-green leaves from 1 to 2 in. long; the majority of the leaves were broken. The sample was free from stalk, and in good condition.

*Sample B.*—Leaves similar to *A* but somewhat lighter in colour and larger, being from 2 to 3 in. long.

*Sample C.*—This was labelled "Dhawa sumac," and consisted of young leaves and twigs, mostly broken, and ranging from brownish-green to reddish-brown in colour. The unbroken leaves measured from  $\frac{1}{2}$  to  $\frac{3}{4}$  in. in length. The sample was in good condition.

The two samples of leaves, *A* and *B*, were stated to be similar, and to consist of a mixture of leaves collected on September 30, 1927, and June 7, 1928; the sample of Dhawa sumac was collected on the same days.

## RESULTS OF EXAMINATION

	Leaves. (A) Per cent.	Leaves. (B) Per cent.	Dhawa sumac. (C) Per cent.
Moisture . . . . .	12.8	12.3	14.0
Insoluble matter . . . . .	44.3	44.5	33.7
Extractive matter (non-tannin) . . . . .	10.0	11.0	13.8
<sup>1</sup> Tannin . . . . .	32.9	32.2	38.5
Ash . . . . .	4.4	3.9	4.0

<sup>2</sup> Tintometer readings :

Red . . . . .	1.5	1.7	1.9
Yellow . . . . .	4.9	5.0	6.5

<sup>1</sup> The determination was made by the method prescribed by the International Association of Leather Trades' Chemists (Hide Powder, Batch B. II).

<sup>2</sup> Determined for a solution containing 0.5 per cent. of tannin in a 1 centimetre cell.

The leather produced by tanning split calf skin (grain side) with infusions of the three samples had the following properties :

*Sample A, Leaves.*—Pale greenish-buff leather, soft and of firm texture.

*Sample B, Leaves.*—Slightly darker leather than that produced by Sample A, and almost devoid of greenish tinge; of firm texture, but not quite so soft as A.

*Sample C, Dhawa sumac.*—The leather was generally similar to that produced by Sample A.

The results of the examination show that all three samples contain high percentages of tannin, the "Dhawa sumac" (young leaves and twigs) being particularly

satisfactory in this respect. In each case the amount of soluble non-tannin extractive matter is advantageously low. The leather produced by the three samples was generally similar, of light colour and good quality.

The leaves of *Anogeissus latifolia* compare very favourably as regards their tannin content with true sumac (*Rhus coriaria*), as Sicilian sumac of good average quality contains 26 to 28 per cent. of tannin.

Previous investigations of *Anogeissus latifolia* leaves were carried out by Fraymouth and Pilgrim (*Bulletin* No. 1, 1918, *Esociet Tannin Research Factory, Indian Munitions Board*). They recorded about 16 per cent. of tannin in samples of leaves and from 25 to 33 per cent. in various samples of " Dhawa sumac " (young leaves and twigs). In " Dhawa sumac " prepared entirely from red leaves they found 49 per cent. of tannin, and as much as 55 per cent. in prepared and sieved " Dhawa sumac."

The samples received at the Imperial Institute were also examined by Professor McCandlish and Mr. F. C. Thompson (Leather Industries Department, The University, Leeds), members of the Advisory Committee on Tanning Materials, who reported a high percentage of tannin in the leaves, similar to the results obtained at the Imperial Institute. They also conducted tanning trials with goat skins and obtained leather of very satisfactory character. The leather, however, proved rather sensitive to light when subjected to sensitivity tests with the mercury vapour lamp. The sensitiveness is greater than that of leather tanned with sumac, and in this respect *Anogeissus latifolia* leaves would be at a disadvantage in comparison with sumac.

Samples of the leather prepared at the Imperial Institute were submitted to firms in the light leather trade, who were favourably impressed and expressed a wish to try the material on a large scale.

#### CONCLUSIONS

The Advisory Committee on Tanning Materials, having considered the results of the investigation and the information relative to the prospects of collecting the leaves on a commercial scale in India which had been furnished by

the Forest Research Institute, Dehra Dun, expressed the following opinion.

The leaves are very rich in tannin and generally of satisfactory composition. They promise to be a very useful tanning material, and would no doubt take a prominent place among tanstuffs for the light leather industry, but it would be unwise to consider the material as a rival to true sumac. With reference to the difficulties which have been experienced in India in drying large quantities of the leaves in the shade, involving the risk of fermentation and consequent loss of tannin, the Committee suggest that it would be desirable to investigate the possibility of employing sun-dried leaves. If leaves prepared in this manner prove to be of sufficiently satisfactory quality the difficulties of preparation should to a large extent be overcome. With this object in view the Committee recommended as the next step in the investigation that about 28 lb. of sun-dried leaves should be prepared and forwarded to the Imperial Institute for further trials.

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#### *ALLANBLACKIA STUHLMANNII* SEEDS FROM TANGANYIKA TERRITORY

IN May, 1929, the Director of the East African Agricultural Research Station, Amani, sent to the Imperial Institute for examination a supply of 42 lb. of the seeds of *Allanblackia Stuhlmannii* Engl. This tree, a member of the natural order Guttiferæ, occurs in the Msambara and Uluguru mountains of Tanganyika, where it is known as "Msambo" and "Mkani." The seeds yield a fat which is occasionally used by the natives as food and, according to Krause and Diesselhorst (*Tropenpflanzer*, 1909, **13**, 281), experiments have been conducted which indicate that the fat contains no harmful constituents. A report on the seeds of the closely related *A. floribunda* from the Gold Coast, known as "Kisidwe," will be found in this BULLETIN (1922, **20**, 463), while reference may also be made to an article, "Contribution à l'étude des allan-

blackia oléifères," by Pieraerts and Adriaens, in *Les Matières Grasses* (1929, No. 253, pp. 8510-8514; No. 254, pp. 8539-8541).

The seeds received at the Imperial Institute were of somewhat irregular shape, varying from 1.25 to 1.8 in. in length, 1 to 1.5 in. in width and 0.8 to 1 in. in thickness. The nuts had a thin, brittle, reddish-brown, woody shell, enclosing a kernel which was pale reddish-brown internally. The shells adhered closely to the kernels and in many cases could only be removed with difficulty.

The seeds consisted of shell 22.6 per cent. and kernel 77.4 per cent. The average weight of the entire seeds was 10.6 grams and of the kernels 8.2 grams.

The kernels contained 5.9 per cent. of moisture and furnished 66.5 per cent. of fat, equal to a yield of 70.7 per cent. of fat expressed on the moisture-free kernels or 51.5 per cent. expressed on the whole seeds as received.

The fat as extracted from the kernels with light petroleum was white, almost odourless, and without any pronounced taste. On examination it was found to have the following constants, which are shown in comparison with those recorded by previous observers for *Allanblackia Stuhlmannii* fat and with the figures obtained at the Imperial Institute for the fat of Kisidwe nuts (*Allanblackia floribunda*) from the Gold Coast :

	<i>Allanblackia Stuhlmannii</i> .		Kisidwe nuts.
	Present sample.	Figures previously recorded.	
Specific gravity at 100°/15° C. .	0.8549	0.8606	0.8563
Refractive index at 40° C. .	1.457	1.4503 <sup>1</sup>	1.458
Melting point (open tube method)	40.0° C.	40.0° to 46.0° C.	38.6° C.
Solidifying point of fatty acids .	60.0° C.	57.5° to 61.6° C.	57.6° C.
Acid value . . . . .	9.9	11.6 to 23.3	1.0
Saponification value. . . . .	189.6	186 to 191.7	190.8
Iodine value . . . . .	39.6 <sup>2</sup>	37.5 to 41.9	44.2 <sup>3</sup>
Unsaponifiable matter <i>per cent.</i>	0.76	—	0.4

<sup>1</sup> At 50° C.

<sup>2</sup> Wijs, 3 hours.

<sup>3</sup> Hübl, 18 hours.

These results show that the fat from the present sample of *A. Stuhlmannii* seeds has properties and constants similar to those recorded by other observers, and also closely resembles the fat from Gold Coast Kisidwe nuts.

The residual meal left after the extraction of the fat from the kernels was yellowish-brown and had a slight, bitter taste. On analysis it gave the following figures, which are shown in comparison with those obtained for the residual meal of the Kisidwe nuts from the Gold Coast :

—	Allanblackia Stuhlmannii meal.		Kisidwe meal.
	Meal as prepared.	Expressed on meal containing 7 per cent. of fat.	Expressed on meal containing 7 per cent. of fat.
	Per cent.	Per cent.	Per cent.
Moisture . . . . .	13·9	13·1	9·3
Crude proteins . . . . .	14·9	14·0	16·4
Fat . . . . .	1·4	7·0	7·0
Carbohydrates (by difference) .	58·6	55·3	52·2
Crude fibre . . . . .	7·7	7·3	8·9
Ash . . . . .	3·5	3·3	6·2
Nutrient ratio . . . . .	1 : 4·2	1 : 5·1	1 : 4·2
Food units . . . . .	99·4	107·8	111

The present meal contained no alkaloids or cyanogenetic glucosides, but a small amount of tannin was present. In these respects, as in its general composition, the meal resembled that of Kisidwe nuts.

The results of examination show that the kernels of these *A. Stuhlmannii* seeds yield a large percentage of a white, firm, somewhat brittle fat, of high melting point. The fat would be readily saleable for soap- or candle-making, and when refined would probably be suitable for edible purposes.

The residual meal contains a rather low percentage of proteins, and as it contains tannin, which imparts to it an astringent taste, it would probably prove unsuitable for use as a feeding-stuff. It might, however, be saleable at a low price as a manure.

As mentioned above, some difficulty was experienced in shelling the seeds, and it may therefore be necessary to export the whole seeds instead of the kernels. In this case the whole seeds would probably be crushed for the extraction of the fat, and if shipped in commercial quantities of 50 to 100 tons they would realise about £14 to £15 per ton in London under present market conditions (October, 1929).

## CYMBOPOGON OILS FROM INDIA

SAMPLES of oil distilled in Burma from two species of *Cymbopogon* have recently been sent for examination to the Imperial Institute by the Economic Botanist at Mandalay. In one case botanical specimens of the grass from which the oil was distilled have been identified at the Royal Botanic Gardens, Kew, as *Cymbopogon clandestinus* Stapf (= *Andropogon clandestinus* Nees, *A. Schoenanthus* subsp. *clandestinus* Hack.), whilst the other is stated to be a new, and hitherto undescribed, species of *Cymbopogon*.

## 1. CYMBOPOGON CLANDESTINUS OIL

This sample consisted of clear, pale yellow oil, with an odour somewhat resembling that of ginger-grass oil.

The oil was found to have the following constants, which are shown in comparison with the corresponding figures recorded by Gildemeister for ginger-grass oil :

	Present sample of <i>C. clandestinus</i> oil.	Ginger-grass oil.
Specific gravity at 15/15° C. . . . .	0.9319	0.900 to 0.953
Optical rotation $\alpha_D$ . . . . .	+ 45.96°	- 30° to + 54°
Refractive index $n_D$ 20° C. . . . .	1.495	1.478 to 1.493
Acid value . . . . .	3.0	Up to 6.2
Ester value before acetylation . . . . .	11.3	8 to 29 (in one case 54.5)
Ester value after acetylation . . . . .	167.1	120 to 200
Aldehydes and/or ketones <i>per cent.</i> . . . .	18 <sup>1</sup>	—
Solubility in 70 per cent. alcohol at 15° C. . . . .	Soluble in 2.1 vols,	Soluble in 2 to 3 vols.

<sup>1</sup> By the neutral sulphite method.

It is of interest to note that in the Annual Reports of the Board of Scientific Advice for India, 1916-17 (page 13) and 1917-18 (page 10), reference is made to the distillation at the Forest Research Institute of two samples of grass obtained respectively from Maymyo and Mandalay, and that as regards the sample from Mandalay it is stated that "It is evident that this grass is similar to *Cymbopogon clandestinus* Stapf, previously received from Maymyo." The oils obtained from these two samples were found at the Forest Research Institute to have the following constants :

	Oil from Maymyo grass.	Oil from Mandalay grass.
Specific gravity at 15/15° C. . . . .	0.9376	0.9428
Optical rotation $\alpha_D$ . . . . .	+ 43° 57'	+ 47° 27'
Refractive index $n_D$ 30° C. . . . .	1.486	1.486
Acid value . . . . .	1.1	0.6
Ester value before acetylation . . . . .	36.9	26.3
Ester value after acetylation . . . . .	210.4	217.9
Solubility in 70 per cent. alcohol . . . . .	Soluble in 2.1 vols.	Soluble in 1.8 vols.

It will be observed that the figures obtained at the Imperial Institute for the present sample are generally similar to those quoted above for the oils examined at the Forest Research Institute, but that the latter samples contained a somewhat higher proportion of esters and alcohols.

The oil was submitted to two firms of essential oil distillers in London.

One firm stated that it is difficult to place a value on the oil until trials with a commercial consignment have been made, but that in their opinion a limited market could be found for it at 6s. to 7s. per lb. in the first instance.

The second firm reported that the sample is not equal in odour to a very good ginger-grass oil; it might, however, be classed as of ordinary commercial grade and would be worth about 7s. 6d. per lb. They added that ginger-grass oil has not been used recently to the same extent as formerly.

This *C. clandestinus* oil has an odour not unlike that of ginger-grass oil, but with a more pronounced odour of carvone. On the whole its constants are similar to those of ginger-grass oil.

Consignments of the oil could probably be sold in competition with ginger-grass oil if offered at about the prices quoted above.

## 2. CYMBOPOGON NOV. SP. OIL

This sample consisted of a clear, pale yellowish-brown, rather viscous oil, with an odour somewhat resembling that of ginger-grass oil.

The oil was found to have the following constants, which are shown in comparison with those obtained

for the *Cymbopogon clandestinus* oil, and those recorded by Gildemeister for ginger-grass oil :

	Present sample of <i>Cymbopogon</i> oil.	<i>C. clandestinus</i> oil.	Ginger-grass oil.
Specific gravity at 15/15° C..	0.9734	0.9319	0.900 to 0.953
Optical rotation $\alpha_D$ . . .	— 48.67°	+ 45.96°	— 30° to + 54°
Refractive index $n_D$ 20° C. .	1.497	1.495	1.478 to 1.493
Acid value . . . . .	4.9	3.0	Up to 6.2
Ester value before acetylation	10.7 <sup>1</sup>	11.3	8 to 29 (in one case 54.5)
Ester value after acetylation	178.1 <sup>1</sup>	167.1	120 to 200
Aldehydes and/or ketones per cent.	11 <sup>2</sup>	18 <sup>2</sup>	—
Solubility in 70 per cent. alcohol at 15° C. . . . .	Soluble in 1.8 vols.	Soluble in 2.1 vols.	Soluble in 2 to 3 vols.

<sup>1</sup> Determined on the residual oil after the removal of aldehydes and/or ketones.

<sup>2</sup> By the neutral sulphite method.

From these figures it will be seen that the constants of the present oil do not differ widely from those of the *C. clandestinus* oil examined at the Imperial Institute, except as regards the optical rotation, which is negative instead of positive, and the specific gravity, which is somewhat higher.

The odours of the two oils were generally similar, but that of the present sample was the stronger and pleasanter of the two.

The oil was submitted to the two firms of essential oil distillers in London who reported on the *C. clandestinus* oil.

One firm regarded the oil as similar to the previous sample, but pointed out that it contained less carvone. In their opinion its market value would be similar to that of the *C. clandestinus* oil, i.e. it might be classed as an ordinary commercial grade of ginger-grass oil, worth about 6s. to 7s. per lb. in London.

The second firm considered the odour of the oil to resemble that of a good quality of ginger-grass oil, and were of opinion that it should realise about 6s. 6d. per lb. on the London market.

It was suggested to the Burma authorities that if this oil could be produced in commercial quantities for sale at prices such as those quoted above, a trial shipment might be sent to the Imperial Institute to test the market.

## ARTICLE

## COCOA

## SELECTION AND USE OF HEAVY-BEARING STRAINS

IN an article on "Cocoa Production in the British Empire" (this BULLETIN, 1919, 17, 40-95) it was mentioned with reference to Trinidad that "experiments on a large scale have been commenced in recent years by the Department of Agriculture with a view to increasing the production by improvements in the methods of cultivation."

The work began in 1910 with manurial experiments, of a conventional type, planned essentially to obtain information of local value. Owing, however, to unexpected results in the course of the first few years attention was soon directed to a study of the variation in bearing capacity of individual cocoa trees, growing under similar conditions. This investigation has been gradually carried forward, step by step, and has led to the attainment of results of fundamental importance to the cocoa planter, not only in Trinidad, but in all other cocoa-producing countries. Some of the Trinidad results have been confirmed, wholly or in part, according to the stage reached, by investigations on similar lines conducted in Java and the Gold Coast. The general outcome is to place at the disposal of the cocoa planter a means of increasing his yield per acre, whether he be forming a new plantation or concerned with the care of an already fully established estate.

*Trinidad*

In a paper entitled "Results of Cacao Research at River Estate, Trinidad" (*Tropical Agriculture*, vi, 1929, 127-133), Mr. W. G. Freeman, then Director of Agriculture in the Colony, gave a summary of the origin of the investigations and the results so far attained.

In 1910 plots of 50 trees each were demarcated in a field of apparently uniform cocoa, and manured in different ways, three plots being left as controls. It was soon obvious that the manurial treatment was a very minor factor in determining the yield of a plot, and after other possible causes had been eliminated it seemed probable

that the yield of a particular plot was mainly dependent on whether that plot contained a high or low proportion of naturally heavy-bearing trees. This working theory was tested by keeping records of the individual yields of several thousand trees on various fields at River Estate and on eight other estates in the Colony. All the trees were unmanured and received similar cultural treatment in each field.

The results were summarised by Mr. J. de Verteuil (*Bull. Dept. Agr. Trinidad and Tobago*, xvi, 1917, 176-198). They showed that the yields of various plots were due to the relative productiveness of the trees in each plot, i.e. on the proportion of heavy- and poor-bearing trees; that a large proportion of trees give less than 13 pods (about 1 lb. of cocoa) per annum even in a very favourable year; that other trees are heavy bearers and that, generally speaking, heavy-bearing trees continue to be heavy bearers and that poor-bearing trees continue to be poor bearers.

How relatively constant in their bearing capacity trees are, and how little poor bearers are affected by even frequent applications of manure, is shown by the following records of seven trees in a plot at River Estate which had received a dressing of a complete manure for each of seven successive years :

*Pods per Tree per Annum*

Tree.	1911-12.	1912-13.	1913-14.	1914-15.	1915-16.	1916-17.	1917-18.	1918-19.
A.	63	102	81	93	100	135	67	106
B.	91	125	123	206	129	191	60	123
C.	51	50	44	48	78	45	55	41
D.	46	41	44	43	32	32	36	44
E.	23	45	33	31	26	26	17	26
F.	3	6	3	7	5	25	3	21
G.	1	6	26	22	30	12	5	19

Whilst on the whole there has been an increase in bearing capacity with increasing age, the poor trees of the first two years, F. and G., are still the poor trees of the last two years, and similarly with the heavy bearers A. and B. and the medium bearers C., D. and E.

Concurrently with these investigations data were collected to ascertain the proportion of poor bearers normally present on cocoa estates in the colony. For

one field at River Estate, de Verteuil obtained the following analysis based on three years' records :

Yield per annum.				Trees per cent.	
0-12	Pods	.	.	.	23
13-25	"	.	.	.	20
26-50	"	.	.	.	30.4
51-75	"	.	.	.	15.9
76-100	"	.	.	.	6.0
over 100	"	.	.	.	4.7

This was supplemented two years later by records, also from three years' observations, on four private estates, three in Trinidad and one in Tobago. Taking the proportions of poor yielders only they showed :

		Trees bearing	
		0-12 pods.	13-25 pods.
		Per cent.	Per cent.
Estate A.	.	51.8	22.0
" B.	.	40.8	21.6
" C.	.	31.1	20.6
" D.	.	12.6	17.0

It is noteworthy that D., the Tobago estate, had been planted mostly by the owner himself from carefully selected seed, whereas the other estates were the result of ordinary "contract" planting. The general conclusions reached from these investigations by the Trinidad Department of Agriculture were (1) that cocoa trees vary naturally in their bearing capacity, (2) that such bearing capacity is not affected fundamentally by manurial treatment, and (3) that on ordinary estates there are to be found 20 to 50 per cent. of very poor bearers (not giving more than 1 lb. of cocoa each) and another 20 per cent. yielding below 2 lb. each. These points being established, the question naturally arose as to how the information gained could be put to practical use. It was necessary to ascertain whether heavy bearing was a hereditary character and also whether it would be possible under estate conditions to replace the large proportion of poor bearers by more productive trees.

To take the latter problem first. In 1919-20 a block of 3,000 trees in one field at River Estate, of which the yield of each for seven years was known, was selected, and every tree which had a lower average yield than 18

Pods ( $1\frac{1}{2}$  lb. of cocoa) a year was removed and replaced by a seedling or budded plant from a known heavy bearer. The new trees began to come into bearing in the season 1924-25. Taking seven of the best developed of the seedlings as an example, they gave in the season 1927-28, although not yet in full bearing, 26 lb. of dry cocoa in place of the 3 lb. which had been the average annual yield for seven years of the poor bearers they have replaced. A line of work is hereby indicated which, pursued steadily, would in the course of comparatively few years effect a marked improvement in the yield per acre of many cocoa estates.

To obtain a more accurate answer to the question, Is heavy bearing hereditary? the following experiment was initiated at River Estate in 1914. Twenty-eight heavy-bearing trees were selected as mother plants.

Six plots of one acre each, with 280 plants, 12 ft. by 12 ft., were laid out, each plot containing 10 plants from each mother plant.

A. Budded plants (budded at stake)	with shade trees.		
B. Budded plants (budded in nursery)	„	„	„
C. Grafted plants	.	.	„
D. Seedlings	.	.	„
E. Budded plants (budded at stake)	without	„	„
F. Seedlings	.	.	„

Each mother plant is thus represented in the experiment by twenty seedling progeny, and forty vegetatively propagated progeny (30 budded and 10 grafted). The trees began to bear in 1917-18 and the number of pods borne annually by each tree has been recorded.

Dr. S. C. Harland analysed the results obtained to the end of the crop year 1927-28 in a paper on "The Yield of Budded and Seedling Cacao" (*Proc. Agr. Soc. Trinidad and Tobago*, xxviii, 1928, 239-248), his general conclusions being stated as follows:

"A heavy-bearing tree may transmit heavy yield to its budded offspring. On the other hand it may absolutely fail to transmit and may give rise to trees which are much worse than the average. There is no method of telling whether a tree will transmit heavy yield

either to its budded or seedling offspring except by testing it.

"It has been shown at River Estate that it is possible to use supplies to replace poor yielders on estates provided that the supplies are of fair size when they are put in. It is recommended that the following types be concentrated on :

Budded, Nos. 1480 and 2190.

Seedling, Nos. 407 and 969.

"These may be confidently expected to give an increase over ordinary trees of more than 60 per cent."

### *Java*

Dr. C. J. J. van Hall has recently written a paper on "Selection of Cacao in Trinidad and in Java" for publication in *Tropical Agriculture* in January 1930, from which it is possible to quote here owing to the receipt of an advance MS. copy.

Commenting on the fact established in Trinidad that a large proportion of the trees on a cocoa estate are poor bearers, he says :

"This is not to be wondered at, when we remember that the mixture of races or varieties planted in our cacao fields is the same as is growing wild in the virgin forest, no selection having been done since the time when the first cacao seeds were brought from the forest and sown out.

"When we realise how great is the difference between the cereals or fruit trees which are planted in our fields and orchards and their wild ancestors, it is evident how far behind we are in planting our cacao fields with the mixture of types—many poor ones and a few superior ones—that is present in our virgin woods. There is no reason to think that we should not be able to attain by selection results with cacao as striking as those which have been obtained by selection of cereals or fruit trees in Europe and America, and we may, therefore, look with interest at the selection work done in Trinidad and in Java."

The origin of the Java work was as follows :

The old Java cocoa was a pure Criollo strain, of first rate quality although inferior to Venezuelan Criollo.

In the hope of obtaining a better strain plants were imported from Venezuela, but on fruiting they proved to be an inferior Forastero type. Seeds from them were, however, sown and the daughter plants bore fruits intermediate between the mother trees received from Venezuela and the old Java cocoa. This type was named the "Djati Roenggo hybrid" after the estate the manager of which, Mr. MacGillavry, made the importation. The hybrid became popular and was planted up as the old Criollo failed. In quality it was only slightly inferior to the Criollo, but its yield was not high.

In 1912 on Djati Roenggo and Getas estates a number of trees of the hybrid were selected which were supposed to be high bearers.

At first twelve trees were so selected, and a few years later another twelve. From these twenty-four trees plots of budded and seedling plants were established, and the yields of both recorded for the years 1923 to 1925, and since then of the budded plots only.

Dr. van Hall discusses in some detail the results obtained, and in summing them up from the practical point of view says, "there is a fairly good chance that a heavy-bearing tree will have a heavy-bearing offspring and that a planter who has no opportunity to do the selection work along scientific lines, by recording the yields of the offspring of each selected tree separately, will still obtain some satisfactory results in using seeds or buds from his best yielding trees instead of using seeds gathered at random. But it is true that in this way he will obtain only a majority of trees belonging to superior races or varieties or strains—the name is immaterial—and a minority belonging to shy bearing strains."

### *Gold Coast*

Records of the individual yields of cocoa trees were commenced by the Gold Coast Department of Agriculture in 1914 at the Aburi Experiment Station, and in 1919 at the Asuansi Experiment Station. A summary of the results obtained is given in two papers by Mr. G. G. Auchinleck, Deputy Director (now Director) of Agriculture, in the Department's *Year Book* for 1927.

At Aburi the experiment field contained in 1914 296 trees, planted 15 by 15 ft., and then 22 to 24 years of age. Their average yield for thirteen years (1914-1926), allowing for trees which have died, has been 95 pods, or 8 lb. of cocoa per tree. This is very high, Mr. Auchinleck noting "the field is therefore an exceptionally good one."

As the outcome of a mode of selection which is described in detail, forty-three trees have been picked out as relatively constant heavy bearers, and it is indicated that the next step will be to obtain budded or grafted progeny from them for trial in another field to test whether their high yields are due to inherent productiveness or merely to accidents of locality.

From the Asuansi Station records are given of the yields of about 200 trees, from 1919, when they were nine years old, to 1926. For this period of eight years the mean percentage of trees in groups based on the number of pods borne per tree per annum was :

No. of Pods.	Trees. Per cent.
0 . . . . .	10.8
1-20 . . . . .	22.9
21-40 . . . . .	15.9
41-60 . . . . .	14.8
61-80 . . . . .	11.4
81-100 . . . . .	8.1
over 100 . . . . .	16.1

The most constant of the high bearers have been selected and these are to be used "as starting points for the work of selecting and propagating high-yielding strains of cocoa. . . . The next step is the propagation of the selected plants and their careful trial by the Department. It should not be forgotten that the high yields of these plants may not be inherent, but may be due to specially favourable positions in the field, and the trial of the second generation is therefore necessary."

"It is clearly useless to grow progeny from seed. It is not known whether cacao is normally self-pollinated or cross-pollinated, nor is the ancestry of the selected trees known. Seed is almost certain to produce plants dissimilar to the parents. A vegetative method is necessary, and as cuttings of cacao grow with exceptional difficulty, recourse must be had to grafts or buds."

## CONCLUSION

As already indicated, however, seedling and vegetatively propagated progeny of selected heavy bearers have been grown on to the fruiting stage in both Trinidad and Java. The results obtained show that whilst by neither method do all the mother plants give rise to heavy-bearing progeny, some of them do. Improvement in crop yield can thus be obtained by two steps. First, select a number of heavy-bearing and otherwise desirable trees, then raise and test the bearing capacity of the progeny (seedlings and budded plants) of these trees, after which a final selection can be made of the mother trees which have been proved to transmit their bearing capacity to their offspring.

With a permanent crop such as cocoa, requiring some seven or eight years to allow of a real test being made of the bearing capacity of a young tree, considerable time is entailed for work of this nature. Advance cannot be made so quickly as with an annual crop, such as wheat or cotton, which is propagated entirely by seed, or even with sugar-cane, with which, when once an improved variety is obtained, it can be increased comparatively quickly by vegetative propagation. In these three cases the fields are cleared every year, or every two or three years, and fresh planting has to be done. There is thus an opportunity of making a test of any new variety or strain without upsetting the estate's working plans or entailing any very abnormal expenditure. In cocoa cultivation the conditions are very different. Once planted and subsequently well looked after, the trees should continue to thrive for a hundred years or even more if the soil and climatic conditions are suitable. There is every reason then that in any new plantings of cocoa from now onwards, every care should be taken to secure strains of proved high-bearing capacity, particularly in countries where cost of production is relatively high.

In the older cocoa-producing countries opportunities for new plantings on any large scale are becoming more and more restricted. Several of these countries, however, possess very extensive areas of established cocoa, planted

usually without any attention having been given to the selection of heavy-bearing trees as parents.

As a result, as shown particularly by the Trinidad investigations, the ordinary cocoa estate contains a high proportion of low-bearing, unprofitable trees. A large number of these are doubtless unprofitable because they are constitutionally poor bearers. Others are so because they have become impaired in health for various reasons, or are growing under unfavourable conditions. That in many cases the defect is constitutional and not due to environment is indicated by the data already quoted, showing that poor-bearing trees were not materially improved by manuring over a considerable period of years, whilst plants of good parentage used to replace poor bearers quickly gave profitable results although grown in the same spots as were formerly occupied by the poor bearers.

The step immediately practicable, and at no very burdensome cost, because the work can be done gradually, is the elimination of the poor bearers, and their replacement by higher-yielding strains, so improving the yield per acre which for cocoa is frequently very low.

Work on similar lines is already being done in the rubber industry of the East, now that it has been shown that *Hevea* trees vary greatly in their natural yield of rubber, and that it is possible to propagate high-yielding strains by budding from selected trees.

The words used recently with regard to rubber in an editorial in the *Tropical Agriculturist* (Ceylon), for July 1929, vol. lxxiii, p. 1, apply equally well to cocoa :

" But whatever the future trend of prices may be it is obvious that estates with low production costs will be in the best position. These costs depend almost entirely on yield per acre."

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## NOTES

**Mangroves of British Malaya.**—Reference has already been made in this BULLETIN (1927, 25, 274) to the occurrence in British Malaya of large areas of mangrove forests. Recently, Malayan mangrove barks have been investigated to determine their tanning value in comparison with that of bark imported from Singapore and

Penang, which is at present used in the local industry, the home-grown product being neglected. The results of the investigation are published in *Malayan Forest Records* (1929, No. 7) entitled "Mangrove Bark as a Tanning Material," by T. A. Buckley, Forest Chemist, Federated Malay States.

For the purpose of this study the bark of only those trees which occur in sufficient numbers to provide adequate commercial supplies of raw material were examined. In the following list are enumerated the various species investigated, together with the average percentage of tannin contained in the moisture-free bark.

	Per cent.
<i>Rhizophora mucronata</i> Lamk. . . .	27.89
<i>Rhizophora conjugata</i> Linn. . . .	16.37
<i>Bruguiera caryophylloides</i> Bl. . . .	15.78
<i>Bruguiera gymnorhiza</i> Lamk. . . .	19.43
<i>Bruguiera eriopetala</i> Wight . . . .	20.27
<i>Bruguiera parviflora</i> Wight . . . .	6.15
<i>Ceriops Candolleana</i> Arn. . . .	24.23
<i>Carapa obovata</i> Bl. . . .	34.13

The bark of the first-named species is the most satisfactory of those examined as it contains more tannin than any other thick bark obtainable in quantity and gives a good yield per tree. The tannin content is liable to vary from tree to tree to an extent as great as 100 per cent. In the case of *R. conjugata*, which is the predominant species, the content is fairly regular but is so low as to make it an inferior material. *B. caryophylloides* has a poor tanning value, the non-tannins being equal to the tannin in amount. *B. gymnorhiza* has a content which is extremely variable but on the whole fairly good. *B. eriopetala* is similar to the last-named species but is of more regular content. *B. parviflora* is hardly worth considering as a tanning material. The tannin of *Ceriops Candolleana* is very unstable, being quickly and completely converted to an insoluble colouring matter which is rapidly precipitated from infusions. This bark might be more useful as a dye than as a tanning material. *Carapa obovata* is the best as regards the percentage of tannin, but the bark is so thin that the yield per tree is small.

Conditions affecting tannin production were also studied. Drying the bark was found to increase the amount of total solubles and the ratio of tannin to non-tannins, but the liquors prepared from dried bark were darker and the increased colour was absorbed by hide. The influence of the position of the bark on the tree was investigated. In the case of *R. mucronata* the tannin

content of strips of bark taken at different heights from the ground did not show much variation, but with *R. conjugata* the higher the position occupied by the strip of bark, the greater generally was the percentage of tannin. Leaving the bark on felled trees did not alter the tannin content. Extraction of the bark with cold water was found to be as efficient as with hot water.

For comparison, samples of mangrove bark as imported from Singapore and Penang were examined. The results showed that the bark of *R. conjugata* from Singapore contained 24.07 per cent. of tannin on the moisture-free material and that from Penang 29.72 per cent. *R. mucronata* barks from Singapore and Penang gave respectively 21.13 and 32.74 per cent. of tannin. It is noticed that the Penang bark in both cases is richer.

In the course of this investigation the following observations have been made. Thick bark from old trees is best. The tannin content of the bark of one tree often varies from that of another tree of the same species. The mode of removal of the bark from the tree and the method of its disintegration before extraction influence the percentage of tannin found. The properties of the bark undergo marked changes during drying. Mangrove bark does not easily develop mould under conditions of free access of air and does not suffer during transit in sacks. For export overseas the bark should, however, be dried to save freight, but need not be dried when transported for local consumption.

**Teak in Trinidad.**—An interesting account of experience gained in planting teak (*Tectona grandis* L.f.) in Trinidad is given by Mr. R. C. Marshall, Conservator of Forests, in *Tropical Woods* (1929, No. 19, p. 1). Teak was introduced into the Colony in 1913 by Mr. C. S. Rogers, then Conservator of Forests, who imported seed from Burma. The experiments have been a marked success, the oldest plantations (15–16 years old) having an average height of about 70 ft. and showing, on a sample plot, a mean annual increment of 126 cu. ft. per acre (quarter-girth measurement, under bark, to a 3-in. minimum diameter of stem wood). It is stated that a rotation of about 60 years is likely to be adopted. A considerable quantity of seed for planting is now available from the young plantations, for the trees bear fertile seed at an early age; no difficulty has been experienced in obtaining rapid germination which, it is understood, is sometimes difficult to secure in Burma. Seedling growth is rapid, a height of from 3 to 6 ft. being reached in the first

rains under favourable circumstances. Nevertheless it has been found that the cheapest and best planting results are obtainable by using root and shoot cuttings of one-year nursery plants. A good burning over of the area to be planted has been found to have a very beneficial effect on the growth of the young trees. So far, there has been no serious disease in the plantations. It may be mentioned that a sample of Trinidad grown teak was shown at the Empire Timber Exhibition held at the Imperial Institute in 1928; the sample is now included in the Trinidad Court of the Public Exhibition Galleries.

**French Colonial Timbers.**—The publications dealing with the timbers found in the French colonial possessions now being prepared by the Association Colonies-Sciences et Comité National des Bois Coloniaux, were referred to in this BULLETIN (1928, 26, 431), where an account was given of a number of recently issued special pamphlets, each dealing with a separate timber, prepared for the benefit of lumber men, merchants and timber users. A second set of these useful pamphlets has been received at the Imperial Institute. The timbers dealt with are: (1) Badi-bilinga (*Sarcocephalus* sp.) found in the Ivory Coast, Cameroons, Gaboon, Moyen-Congo and also in the Gold Coast; (2) Samba-ayous (*Triplochiton scleroxylon* K. Schum.), the Obeche or Arere of Southern Nigeria, and occurring in the Ivory Coast, Cameroons and the Gold Coast; it is now marketed in the United Kingdom; (3) Banlang (*Lagerstrœmia* spp.) from French Indo-China, a timber similar to well-known Indian and Burma woods; and (4) Angelique (*Dicorynia paraënsis* Benth.), an important timber of French Guiana. It will be observed that the selection of woods in this further instalment of the series is a notable one. The scheme of arrangement of the pamphlets is as previously described and again merits reference to its practical utility.

## RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government  
Technical Departments Overseas

### AGRICULTURE

#### SOILS

**Ceylon.**—Soil erosion experiments have been continued at the Experiment Station, Peradeniya. The third year of the experiment testing the efficacy of the cover plant

*Indigofera endecaphylla* and of contour hedges of *Clitoria cajanifolia* in lessening erosion ended in May, 1929. The effect of the treatments is now marked. In the past year after the treatments were started, erosion, compared with the control plots, was lessened as follows: *Indigofera* plots by 0.5 per cent., *Clitoria* plots by 7.7 per cent. This year the reduction of erosion was respectively 43.7 per cent. and 39.3 per cent. The benefit of cover plants and contour hedges in reducing soil erosion can now be regarded as having been demonstrated experimentally. But even from the *Indigofera* plots, soil was lost during the last year at the rate of over five tons per acre. The plots are steep, but no steeper than much of the land planted with tea in Ceylon; the danger of soil erosion is therefore obvious.

The Agricultural Chemist reports that the 1928 results of leaching and drainage trials confirm those obtained in 1927, viz. that losses of fertilisers from the cropped pots are very much less than those from the non-cropped pots and that nitrates and lime are lost in largest amounts. Analysis showed that magnesium was present in fairly large amounts in the drainage waters. In 1929 the experiment was modified so that the comparative losses of only the three main soluble nitrogenous fertilisers in the drainage waters could be obtained.

Studies on the nitrate variation in Ceylon soils carried out for a year appear to indicate that the nitrate contents at the times of sampling are highest in the limed and manured plots, and least in the sugar-cane and boga plots. A statistical study has been made of the variation in nitrate content in one of the plots. This has shown that the variations of soil nitrate in a plot one twenty-fourth of an acre in extent are comparatively small.

#### MANURES

**Ceylon.**—Mr. A. W. R. Joachim, the Agricultural Chemist, reports that field studies on the effects of green manuring on arable soils have been carried out. Samplings of soils from the permanent green manure plots at the Experiment Station, Peradeniya, were made in March, 1929, and their nitrogen contents and  $pH$  values determined. The results indicate that though there are no appreciable increases in the nitrogen contents of the green-manured plots as compared with those found in the 1928 samples, the nitrogen contents of the 1929 controls had fallen distinctly. Green manuring under the climatic conditions at Peradeniya has therefore resulted in a maintenance of soil fertility. The study of the changes in carbon contents of the soils is to be undertaken shortly.

There is apparently no change in soil reaction brought about by green manuring, as the results of  $pH$  determinations carried out by the Bilmann quinhydrone method on the 1928 and 1929 samples indicate.

Laboratory and field experiments on green manuring under paddy-land (anaerobic) conditions were completed during the period January 1 to June 30, 1929. From the chemical data obtained it appeared evident that (1) green manuring of paddy is of direct manurial value and of decided advantage to the crop, large quantities of ammoniacal nitrogen being found in the green-manured plots at all stages of the growth of the crop; (2) green manuring of paddy lands should be carried out as late as possible before sowing if maximum yields are to be secured; (3) by green manuring paddy the nitrogen content of the soil may be maintained and even increased; (4) nitrates should on no account be used as a fertiliser for paddy land owing to the losses of nitrogen that take place through leaching and denitrification and the formation of nitrates harmful to paddy seedlings. The field experiments indicate conclusively that late green manuring of paddy is decidedly preferable to early green manuring, and that both are preferable to no green manuring.

An experiment in the change in composition of green manure was started to determine the change in composition and "decomposability" with age of different parts of representative tree and shrub green manures. The results obtained appear to indicate that the total nitrogen and ash contents increase with age to about the time of flowering, when they are at a maximum, after which they decrease.

In order to determine the relation of green manures and cover crops to soil moisture, moisture determinations of soil samples taken from the green manure plots at the end of a period of drought lasting nearly three months were made and confirm the results of previous investigations, besides indicating the importance of the shade effect of the green manure trees. The results also appear to point that the correct time of burial of green manures, from the point of view of soil moisture, is towards the end of the rains.

## BEVERAGES

### Cocoa

**Ceylon.**—The Inspector for Plant Pests and Diseases of the Central Division reports that *Helopeltis antonii* Sign., *Arbela quadrinotata* Wlk., and *Aularches miliaris* Fab., are the insects most frequently met with on cocoa.

*A. miliaris* has been less frequent during the first half year of 1929 than in the previous year. Squirrels of the genus *Funambulus* do a great deal of damage to the crop throughout the Division, particularly in village gardens. The Kalutara Snail (*Achatina fulica*) is responsible for a very great deal of damage to the blossom, again particularly in village gardens. It must be remembered that the religious beliefs of the villager do not allow him to take life in any form, and consequently the destruction of pests is at a discount in village gardens.

**Gold Coast.**—The Acting Director of Agriculture has furnished the following summary of the investigational work on cocoa carried out by the Department during the period January to June, 1929.

The recording of yields from areas and individual trees has been continued on Investigational Stations. Standard manurial trials were continued, and fork-mulch trials and new manurial trials proceeded with; key tree records of yields are kept separately and constitute a fundamental part of the fork-mulch trials and new manurial trials. Daily counts of flowering, flower shedding, fruit setting and growth measurements of pods were continued. The effect of climatic factors on pollination, flower shedding, fruit setting and shedding was observed, selfing on selected trees proceeded with, and the resulting seeds were sown. Short interval pickings with special fermentation have been begun to provide greater detail in investigations of crop production.

Trials with various cover crops as nurse plants of cocoa were conducted, *Crotalaria striata* being probably the most successful so far. Results of attempts to grow cover crops under established cocoa are not encouraging.

Investigations of the possibilities of various methods of vegetative reproduction of cocoa are proceeding. The results are as yet inconclusive.

The examination of cocoa at ports was continued. With a view to increasing the accuracy of information available for crop forecasting, observation plots have been selected covering as far as possible the cocoa-growing areas, from which data will be gathered in forthcoming seasons.

The Entomologist has investigated the occurrence of the principal insect pests of cocoa in Fernando Po, San Thomé and the Belgian Congo. It was found that *Sahlbergella singularis* Hagl. was almost as common in Fernando Po as in the Gold Coast, but that the parasite, *Euphorus sahlbergellæ* Wilk., was far more abundant owing to the absence of the hyperparasite, *Mesochorus*

*melanothorax* Wilk. ; that *S. singularis* has been responsible for the loss of large areas of cocoa in the southern part of the Belgian Congo following two consecutive years of low rainfall. *S. theobroma* was not observed in all three countries. Other pests, with few exceptions, were found to be similar to those that occur in the Gold Coast. In his opinion the enormous amount of damage done by *Heliothrips rubrocinctus* Giard. in San Thomé is due to the absence of the Eulophid parasite, *Dasyscaphus parvipennis* Gahan, which is an efficient control on the mainland.

Since the Entomologist's return, work has been instituted on the bionomics of *Euphorus sahlbergellæ* and the possibility of the breeding of the insect under artificial conditions, with a view to distribution to areas of recent attack. It is of interest to note that this parasite has not yet been observed to parasitise *S. theobroma* in the field or under laboratory conditions. No parasite of *S. theobroma* is known. Figures are also being obtained of percentage parasitism in the field at different periods of the year.

A survey is in progress of the alternative food plants of *Sahlbergella* spp. They have been reported as feeding on *Eriodendron*, *Bombax* and *Cola*. At Asamankese it has been found that *S. theobroma* will feed and breed on *Eriodendron* suckers but not *S. singularis*. It has also been found that neither species will feed on *Bombax* suckers.

It has been known for some time that cocoa trees infested with the red tree ant, *Oecophylla smagdarina*, are practically immune against attack by *Sahlbergella*. Experiments are in hand as to the best means of infesting trees with this ant and the conditions which favour it. In the Gold Coast this ant cultivates two scales, (1) *Stictococcus* spp. and (2) a pink species not yet identified. Both species do little damage to the tree in proportion to that done by *Sahlbergella*. *Stictococcus* spp., however, attack the developing pods, causing distortion. When a tree comes into bearing there is little liability of attack by *S. theobroma*, which is more serious than attack by *S. singularis*, and the nests can therefore be removed.

Continuous life-history records are being carried out with a view to finding any variation there may be at different periods of the year.

An index is being obtained of the *Sahlbergella* population in relation to growth and climatic conditions at different periods of the year.

In addition to the parasite, *Euphorus sahlbergellæ*, numerous casual predators are responsible for the deaths of numbers of nymphs. These are being ascertained.

**Nigeria.**—According to the Report of the Senior Mycologist, Southern Division, experiments on fermentation of cocoa beans have shown that if air is partially excluded from the beans during the process the product is indifferently fermented and moulds appear at an early date; a disagreeable odour is also induced. Moreover, the keeping qualities of such beans are poor. The best sample was obtained when the beans were changed twice daily during fermentation. The *Aspergilli* obtained were identified at the Imperial Bureau of Mycology and found to be *A. flavus* Link, *A. tamari* Kita and *A. fumigatus* Fresen., all of which have previously been reported as occurring on mouldy cocoa in the Gold Coast. There is one other form which has not been previously received by the Bureau and this has not been identified yet.

Further experiments have been carried out on the moisture content of cocoa in relation to moulding and a standardised method of estimating the percentage moisture of the product has been outlined and will be elaborated during the next season.

The hygroscopic moisture within the cocoa bean has been found to be in equilibrium with the relative humidity of the atmosphere after the fourth day of sun-drying, and after this period unless the beans are covered at night they may actually reabsorb more moisture, depending upon the relative humidity obtaining at night, than was lost by drying throughout the preceding day.

### *Tea*

**Ceylon.**—The following statement regarding the pests of the tea plant appears in the Report of the Inspector for Plant Pests and Diseases for the Central Division.

**Shot-hole Borer** (*Xyleborus fornicatus* Eich.).—The regulations governing shot-hole borer were amended in January, 1929. Under the amended regulations, permits for the removal of tea plants shall be issued only to nurseries registered as such with the Department, and these nurseries shall be graded by the Department into classes A, B, C, D and E, each grade limiting the area of distribution of the plants. Certificates of registration and grading are issued to the nurseries. Grade E indicates shot-hole borer infested stock, and the regulations require that such stock shall be uprooted and destroyed by fire. These regulations aim at checking the distribution of the borer, promoting better methods of cultivation, and better nursery stock. Few changes are accepted without suspicion by the cultivator, and though these amended regulations show a tendency on his part to refrain from

registering nurseries and consequently selling stock no harm whatsoever accrues therefrom to the industry.

*Tea Tortrix* (*Homona coffearia* Neit.).—The regulations governing this pest and which require the collection and destruction of all egg-masses on tea have been in operation twenty-one months. Opinions as to the effectiveness of the regulations vary considerably. Figures from quarterly returns show that very large numbers of egg-masses have been destroyed, but they do not show, with the same veracity, that the insect is less because of these regulations. Unfortunately funds have not been sufficient to allow of regular inspection of all estates in the Tortrix areas, without which meticulous adherence to the regulation by all estates cannot be assured.

**Federated Malay States.**—The Acting Agriculturist, Government Plantations, reports that the total area of tea at the Experiment Station, Tanah Rata, Cameron's Highlands, is now 28 acres. The tea area is situated at an elevation of about 4,750 ft. Calculated yields of made tea from a small area of Assam tea planted in January, 1926, are 470 and 525 lb. for the first two years of cropping respectively.

## CEREALS

### *Rice*

**Ceylon.**—The Economic Botanist reports that during the first half-year, 1929, routine work on the pedigree selection of rice, on preliminary and field trials of selections, and on their maintenance of purity has continued on the lines described in the annual reports for 1927 and 1928. Trials were conducted at the four central selection stations and by the divisional staff of the Department at the twenty-three paddy seed stations.

The first series of permanent manurial experiments with rice were harvested and the results were distinctly promising. Sulphate of ammonia with superphosphate, ammophos and steamed bone meal with or without green manure have given profitable increases in yield. The experiments indicate that in areas where paddy occupies the land for most of the year green manures are very effective. Another experiment has shown that green manure is more beneficial when applied just before the crop is planted.

Trials of foreign paddies have been continued. Mandalay *ngasein* has given promise at two centres. The Californian paddies tried last year proved unable to stand the wet conditions at Peradeniya this year. *Ngasein*

was crossed with a local *maha* paddy, as was also the Madras paddy CEB 24.

The investigations into the technique of field experimentation were continued. Irrigation and green manure experiments in pots were laid down in the plant cage.

At the recently established experimental station at Kurunegala in the North-Western Division, according to the Agricultural Officer in charge, nine pure line types and one control were replicated eight times on trial plots. Seed paddy was sown in nursery beds on September 18, 1928, and transplanted between October 20 and 25. The plots were harvested between February 5 and 15, and the following yields were obtained :

Name of variety.	Average weight per plot.	Ratio : Control = 100	Average measures per plot.	Ratio : Control = 100.
a 8 Podiwi . . .	14.65	100.97	9.68	99.68
a 12 Podiwi. . .	14.39	99.3	9.37	96.47
b 13 Mawi . . .	11.67	80.40	7.59	78.13
g 18 M. Samba . . .	12.01	2.77	7.78	80.06
117 Mawi . . .	17.28	119.09	11.21	115.43
P 5 Sudumawi . . .	16.5	113.6	11.12	114.48
P 9 " . . .	13.65	94.08	9.14	94.05
P 10 " . . .	14.25	98.24	9.39	96.14
W 15 Mawi . . .	15.0	103.34	9.75	100.32
Control Puluk Samba . .	14.41	100.0	9.71	100.0

In the other plots at Kurunegala nine varieties of paddy were sown broadcast on September 18 for the purpose of raising seed paddy for distribution to village cultivators. A month after the date of sowing there was a severe drought lasting over five weeks, and many seedlings were killed. There was sufficient rain during the latter part of November.

In the report of the Agricultural Officer of the South-Western Division, mention is made of the work carried out in various stations in the Colombo and Negombo districts. After experimentation at the Belunmahara Paddy Experiment Station a paddy, B 13 (Kuruluthuduwi), was found to be the most suitable. At Batugedera Paddy Station four pedigree varieties of paddy, G 3, P 9, B 13 and R 11, with rathkunda as control, were tried in ten randomised blocks. G 3 was the best and yield of paddy of the multiplication plot of this variety has been reserved for distribution among cultivators. At Godakawela Paddy Station the following varieties were tried : HF 9, HK 13 and local haleli. As the results were not encouraging two new pedigree varieties, Mb 14 and 1 cpy, and local haleli were sown.

**Federated Malay States.**—The Acting Economic Botanist reports that the padi season in Krian was nearly two months late owing to adverse weather conditions. The yields recorded were about 5 millions of gallons below the average of the past nineteen years, the actual returns given by the figures being but 64 per cent. of an average crop. Large losses of padi were caused by the attacks of stem borer. At the Titi Serong Station, the infestation of the stem borers in many of the pedigree lines and increase plots was particularly severe, but sufficient seed was obtained to carry on the experiments.

An investigation was made of hybridisation methods, and one was found which enables successful crosses to be made between seven pedigree strains. Fifty-one ripe hybrid grains were obtained for sowing next season.

The experiments concerning the storage of rice were continued.

The Acting Government Entomologist reports that the stem borers responsible for the damage done in Krian and other rice-growing areas are two species of *Diatraea*, *D. auricilia* Dugl. and an unnamed species. Information has been gained regarding the duration of the life-cycle of the first-named, and facts regarding alternative host-plants have been established. An experiment in breeding a parasite, *Trichogramma* sp., is being carried out, the object being to liberate them in infested rice-areas, when the number of parasites is sufficiently great. To accomplish this, attempts are being made to establish a large colony of the moth on the ova of which the parasites are propagated. The moth at present being utilised is *Sitotroga cerealella* Ol.

**Nigeria.**—The following note on experimental work carried out in the Northern Province is contained in the Report of that Department for the first half-year, 1929.

Fifty-two single plant selections representing many native varieties and three introduced varieties (Guiana Creole, Guiana 75 and Maliya) have been planted in replicated rows under irrigation at Kworre near Sokoto. In addition 76 selfed heads of the above selections have been planted at Samaru.

Seed of a number of selected strains and of commercial varieties has been obtained from the Economic Botanist, Mandalay, and will be planted next season.

## SUGAR

### Cane

**Ceylon.**—The Divisional Agricultural Officer, Northern Division, reports that during the first half of the year no

sugar was made as the ratoon crops were not matured enough for sugar making. The ratoon crops in the field were from canes planted in 1927. These were doing very well. The varieties of canes that were in the field were: (1) striped white tana, (2) cherribon, (3) barbados 208, (4) 55 P, (5) No. 1237, (6) sennammore, (7) stripped tana, (8) D.K. 54, (9) 131 P., (10) No. 3390. Before sugar is made in the large boiling pans, tests are made in the small testing pans to verify the proportion of lime that the juice requires for the formation of sugar. From one-quarter acre of variety No. 3390, 840 lb. of sugar was made. The sugar made from this variety was good and the canes are very suitable for sugar-making. From one-thirty-second of an acre of 131 P, 85 lb. of sugar were made. No pests attacked the canes.

**Trinidad.**—The Acting Director of Agriculture has forwarded a comprehensive report on the work of the Froghopper Investigation Committee which was formed at the end of 1925. The report consists of two parts:

(1) A general summary by Mr. W. G. Freeman, until recently Director of Agriculture and Chairman of the Committee.

(2) A detailed account by Prof. F. Hardy, Chairman of the Scientific Committee, of the work done and suggested lines of future research:

Mr. Freeman states that:

“When the Committee began its work in November, 1925, Mr. W. Nowell, presenting the position as then known from the work of previous investigators, notably Mr. C. B. Williams, wrote ‘The general conclusion indicated is that an agriculturally imperfect condition of the soil, from whatever cause it may arise, is favourable to the development of froghopper infestation in years when the general climatic conditions are suitable.’

“In years of favourable climatic conditions, there is very little damage anywhere. In the unfavourable years, canes on soils, such as at St. Augustine, etc., suffer but little; at Chaguanas, Couva, etc., large areas suffer severely, and in the Naparimas, where the soils are more varied, canes are heavily blighted on the red soils, and blight-free, or nearly so, on the black soils. This is the case even when, as not infrequently happens, red and black soils occur in one and the same field. All other conditions must then be very similar, viz. climate, cultural methods, relative abundance of parasites and other enemies, and presumably exposure to froghopper attack. The soil conditions alone differ.

"C. B. Williams in his general summary (*Dept. of Agr. Memoir*, No. 1, 1921, p. 158) said: 'Chemical analysis of a number of soils of damaged and undamaged fields shows that the undamaged fields are, on an average, alkaline or neutral in reaction, with a higher content of lime, carbon dioxide and humus. The damaged fields were neutral or acid with a lower percentage of lime, carbon dioxide and humus, and possibly a higher relative amount of  $\text{SO}_3$ .'

"Williams worked with very limited resources, and modern methods of analysing rapidly and with greater accuracy large numbers of soils were not available to him. He was thus unable to arrive at a definite conclusion.

"One of the main lines of work under the present Committee has been to prosecute extensive soil research, to ascertain whether the factor favouring froghopper blight is acidity, water content, toxicity due to other substances, etc. In short, to determine what are the conditions which make a soil agriculturally imperfect and so favourable to the development of froghopper blight, and, if these conditions can be ascertained, whether it is possible to remedy them at a cost and by methods which are possible in estate practice.

"Many of the lines of work summarised in Prof. Hardy's memorandum are directed to this end.

"A definite conclusion has been reached on the question of acidity. Some thousands of soil samples have been taken and analysed, and, when the results are correlated with prevalence of blight, it is clearly proved that the lime status of the soil is a factor of primary importance; the greater the acidity of the soil, the greater the susceptibility to froghopper damage.

"Maps have been prepared for all the chief sugar estates, showing the condition of the soil for each field as regards acidity, and the data are sufficiently complete to give the number of tons of lime per acre necessary to correct this acidity. This marks an important advance.

"The next step, which has already been taken, is to ascertain by carefully planned and properly supervised experiments whether it is a practicable estate proposition to make good this deficiency in lime, and if so, whether freedom from froghopper blight on such soils will then be obtained.

"It is dangerous to prophesy, but it may be found that it is possible, where the lime requirements are relatively low, to correct soil acidity at a not prohibitive cost, and give such areas a much greater freedom from froghopper blight. On other areas, where the lime

requirements are very high, and the physical condition of the soil particularly unfavourable, it may not be practicable at all, or only at a prohibitive cost. In either case the results will be of great economic value, even if we are forced to the conclusion that, for certain soils, sugar-cane cultivation resembles a gamble, dependent on climatic conditions.

"One result of immediate practical importance has been the discovery that in Cyanogas we have a material which can be used on an estate scale to destroy the nymphs, which, owing to their being immersed in 'spittle' and imbedded in cracks, etc., in the soil, are well protected against most insecticides. This will doubtless be effective against the first brood and so help in at any rate partial control in a bad year. It is improbable that it could be effectively employed in a really bad year against the later and large broods, should such develop. Cyanogas will doubtless be a very useful palliative, but, as with other pests such as thrips and cacao beetle, it is the improvement in cultural conditions, including for the former, soil improvement, which forms the real method of control. The investigations on the froghopper conducted by the Committee afford hope that it may be possible to effect such permanent improvement that the sugar industry of the island will substantially benefit if the work now in hand is carried to its conclusion, and yields the hoped-for results."

Prof. Hardy gives a very full account of the problem in all its phases, and then summarises the practical issues of the investigations and the lines of future research as follows :

#### (A)—*Entomological Phase*

(1) In the use of *Cyanogas* appears to lie a practicable means of at least partially controlling the spread of frog-hoppers in cane-fields. The insecticide is easily the best that has yet been tested for this purpose. It is to be hoped that planters will persevere with its application. Its efficacy as ovicide has not yet been proved.

(2) The practice of *bare-fallowing* well-ploughed land for destroying eggs (as well as for other and perhaps more important reasons, such as better aeration, and dehydration of colloidal clay, leading to improved tilth), should be given serious consideration.

(3) The use of improved forms of *light-traps* for catching adults should be more seriously tried.

(4) *Bird sanctuaries* and *frog-ponds* should be constructed near cane-fields in all cane-growing areas.

(5) A thorough trial of the newer methods of biological control, such as those suggested by Dr. Myers, should be initiated.

#### (B)—*Mycological Phase*

The possibilities of employing artificially-grown and disseminated spores of *Green Muscardine* fungus, when conditions favour its successful application, should not be forgotten.

#### (C)—*Agricultural Phase*

(1) The greater and more extended use of *organic manures*, both natural and synthetic, should be encouraged.

(2) Field experiments to test the value of various *mineral fertilisers*, with and without *pen-manure* and *lime*, should be further multiplied in all the cane-growing areas.

(3) Fuller use might be made of *cover-crops*. There is need of controlled and unified plot-trials of the different crops suggested, and of experiments to test the conditions controlling seed production.

(4) *Irrigation* in the dry season should certainly be further attempted in districts where it is practicable. The irrigation channels could be used for artificial *flooding* for driving-up nymphs.

(5) Methods of *tillage* and *drainage* require no stressing, but progress in their study is slow, and naturally depends on many factors that lie outside the sphere of the scientific investigator. Laboratory studies of the effects of tillage and of drainage have recently been initiated by Turner. They are leading to detailed field experiments in collaboration with planters.

(6) *Liming* certainly deserves more serious attention by all estate managements. One of the chief difficulties in the field is to get the lime well worked into the soil down to a considerable depth. Dressings that penetrate a few inches only (which appears to be the case in most of the heavier cane-lands that so far have been artificially limed) are almost useless (*vide* Turner ; Harmony Hall liming trials, *J. Ag. Sci.*, XIX, 1929, pp. 83-89). Definite experimental results in support of the economic value of liming are still lacking, however, but a number of liming experiments, inaugurated by the Froghopper Committee, are now in progress on several sugar-estates. These experiments vary in complexity.

The effect of lime on the soil in most of these experiments is being traced by chemical analysis in the

laboratory. In addition, lysimeter (drain pipe) trials with many of the acidic soil types have been set up at Curepe.

In order to aid managers in the selection of suitable fields for estate liming, a detailed lime-deficiency soil map, on the 1:26 in. to the mile scale, has been prepared for the whole of the cane-growing area of Trinidad. This has entailed the collection of over 4,000 soil samples in the field. From these, some 200 composite samples have been prepared for detailed chemical analysis. A new electrometric laboratory method for rapidly measuring lime-requirements has been devised and applied to these composite samples (*J. Ag. Sci.*, XIX, 1929, pp. 17-25; Hardy and Lewis). It is therefore now possible to advise estate managers where and how much to lime. Already advantage has been taken of this possibility, notably by the managements of the Caroni and of the Waterloo Estates. Such activity has aroused the interest of local manufacturers of pulverised limestone, who have been helped by the performance of laboratory analyses of their materials and products. In addition, the natural limestone and calcareous marl outcrops in the Naparima area have been examined as possible sources of agricultural lime for the application to the fields of the U.S.M. Estates.

#### (D)—*Biochemical Phase*

The practical issues from the biochemical phase of the investigations so far are largely general agricultural problems. Thus, in order to improve (*a*) reaction and lime relations of the soil, (*b*) water relations, (*c*) aluminium and iron relations, (*d*) nutrient relations, and (*e*) oxygen relations of the root, greater attention must be given to drainage, tillage, liming and the use of organic manures and artificial fertilisers. Phosphatic fertilisers perhaps have not yet received the especial attention they appear to deserve in Trinidad sugar-cane cultivation, not particularly in relation to their direct value as plant nutrient, but on account of the well-known fact that they lessen aluminium and iron injury in certain soil types. Potassic fertilisers also require further trial. So far, most of the experiments seem to have been performed on soil that is highly acidic in reaction and very deficient in lime. It is evident that such trials may be unsatisfactory. One of the most pressing needs at the present juncture is the formulation and initiation of really precise and critical fertiliser trials on the different soil types that the recently completed soil survey has delineated. The fertiliser experiments that have so far been attempted, for example, those at U.S.M. and at the Government Experiment

Station, apply to soil-types that by no means include all those now known to exist in the Trinidad cane-lands.

Really reliable data as to the economic value of fertiliser applications can only be obtained by elaborate experiments which entail the closest co-operation between planters and trained specialists.

The progress of the Froghopper Investigation, as outlined in the foregoing paragraphs, definitely leads to the conclusion that much more field experimentation is required if the numerous suggestive facts that have so far been disclosed are to be pursued to their ultimate agricultural issue. The investigation is trending, on the one hand, towards fundamental researches into the ecology of the cane-plant and its pests and diseases and, on the other hand, towards renewed efforts to put the various theories to proper practical test. The former aspect concerns mainly the scientific investigator; the latter definitely involves the personal attention of the planter.

### *Lines of Future Research*

It will readily be conceded that the complete story of froghopper blight has not yet been told. It is to be hoped that the various phases of the problem now receiving attention should as far as possible be completed. This will entail at least another year's work along the lines already initiated. The following projects especially should not be abandoned :

- (1) Trials with Cyanogas for nymph eradication.
- (2) Trials of ovicides in the field.
- (3) Attempts to discover a suitable insecticide for adult froghoppers.
- (4) Biological control of the froghopper.
- (5) Study of the effects of lime and other ameliorants on the soil ; lime penetration.
- (6) Study of the effects of fertilisers.
- (7) Mechanism of the interaction between environmental growth conditions and cane-plant in relation to blight susceptibility and resistance.
- (8) Sub-soil studies : aeration ; toxicity due to aluminium and iron compounds ; water movement ; mechanical effects of deep cultivation ; root penetration ; root-fungus ecology.
- (9) Effect of soil conditions on the composition of the cane-plant, particularly leaf-sap and cane-juice.
- (10) Completion of soil-survey.
- (11) Further characterisation of soil-types by profile studies.

(12) Further analyses of composite soil-samples (potash, phosphate, nitrogen, organic matter).

(13) Decay of plant residues in the soil; humification; ammonification; nitrification; nitrogen-fixation.

(14) Sand-culture nutrition experiments.

## ROOT CROPS

### *Sweet Potatoes*

**Uganda.**—The manager of the Serere Plantation reports that only a light yield of sweet potatoes was obtained from last season's crop harvested early this year, the  $3\frac{3}{4}$  acres averaging out at only 1,396 lb. of fresh tubers per acre. The resultant tubers were sliced, dried and stored, and it was found that 100 lb. of fresh tubers gave on an average 21 lb. of the dried article.

### *Yams*

**Nigeria.**—Considerable work has been carried out by the Entomological Branch of the Department of Agriculture in the subject of the yam beetles and the following is a summary of experiments on the effect of various poisons on the beetles. These experiments were undertaken to test the possibility of poisoning the yam beetles when they arrive in the farms and feed on the seed yams.

*Tephrosia Vogellii*.—Extracts of this plant have been shown (Tattersfield, Gimmingham and Morris, *Ann. Appl. Biol.*, XII, No. 1) to be highly toxic as a contact insecticide, but there seem to be no records of its use as an internal poison.

Leaves were found to be the most toxic, so a simple aqueous extraction was made and the seed yam left to soak in it for a day or more; beetles were then put in a cage with the poisoned yam.

It was found that the beetles readily fed on the yam, however strong the poison extract, without showing any ill effect. Pieces of yam were impregnated with the extract in vacuo and yam was also coated with a mixture of cassava starch paste and *Tephrosia* extract, but all with negative results.

The extract was tested on small fish and was found to be highly toxic. It was also tested on mosquito larvæ, but the larvæ thrived in strong solutions. Adult mosquitoes seemed to be attracted to the extract for oviposition.

One of the toxic principles of the plant was extracted

with chloroform, the extract was taken up in a very small quantity of toluene and emulsified with water. This was then sprayed on yam, but the beetles would not touch it.

*Sodium Arsenate.*—Sodium arsenate was dissolved in water in various strengths and yam was soaked in the poison. Beetles fed on the yam treated with the strongest solution without ill effect.

*Para-dichlorobenzene.*—A small piece of this chemical placed in the soil with beetles was found to be highly toxic. If  $\frac{1}{2}$  gram was placed in each yam heap the cost of the treatment would be about 5s. per acre, but even then the effect would not last long as the chemical evaporates very rapidly.

It seems, therefore, that poisoning the beetles is not a simple matter, but it is hoped to try out other native poisons later.

*Effect of the height of the Benue on beetle infestation.*—From the limited data available there is evidence that the recent beetle epidemic in the Benue Province may have been due to a sequence of years with unusually high flood level in the Benue extending the breeding ground of the beetle. In 1923, 1924, 1925 the Benue was unusually high. The beetle epidemic seems to have first become general in 1925. The Niger was higher in 1924 than in any other year covered by the records (1918–28).

It is possible, therefore, that the height of the big rivers in September one year may prove a useful indication of beetle infestation the following year.

## FRUITS

### *Citrus*

*St. Lucia.*—Mr. E. W. Walters, Agricultural Superintendent, has furnished the Imperial Institute with the following summary of the work of his department on Citrus fruits during the period January to June, 1929.

A consignment of 529 Florida grapefruit plants was imported into the colony on November 17, 1928, from the Glen St. Mary Nurseries, Florida.

The plants arrived in good condition, showing only short areas of dead wood which had died back from the pruned head. They were immediately fumigated with the appropriate strength of hydrocyanic gas. The following treatment was given prior to distribution: All plants were carefully inspected, and traces of scale infestations were cleaned away with whale oil soap; the dead and

damaged wood was pruned away and the cuts were white-leaded, after which the plants were puddled and distributed in burlap wrapping.

Growth commenced at about two weeks after setting out, which was done in the manner prescribed by Prof. Clark Powell; the weather at this time was cool and wet. A number of trees did not break into growth readily and these were subsequently affected by saprophytes and continued to die back. A few were saved by drastic pruning to a new bud. A *Tubercularia* was prominent on the dead wood when imported and reappeared on the dying plants, together with two root-rots which caused some of the subsequent losses. The first root-rot produced a slimy and shredded condition of the entire root system, and was identified as a *Sclerotinia*, showing white coarse hyphæ and black sclerotia. The second rot was a dry rot; no fungi could be found to account for it.

Early treatment of die-back wood and careful general attention prevented further severe losses after the plants had come into vigorous growth. The total losses amount to about eighty plants, and these are mainly of the "Duncan" variety. This was given special attention in view of the large number ordered, and the losses were found to be due mainly to the inactive condition of many of the root stocks, and partly to drying out and sun-scorch. The too liberal use of crude Solignum also caused a scorch of the bark and foliage.

The remainder of the plants are now in good condition and growing well in spite of a recent serious drought. The sites are diverse, varying from home gardens to cocoa estates and new clearings. The best plants have headed well and are being trained to make permanent scaffold branches. From the 24 plants established at Union, 120 have been budded from numbered parents and are being distributed to replace those lost. Budding is conducted on young sour lime stock using plump normal buds at 10 in. above ground.

The general expression is one of interest in grape-fruit culture and several orders have been given for local plants.

*Examination of Raw Lime Juice.*—The following report has been received from the California Fruit Growers' Exchange, on samples of raw lime juice and information submitted by the Agricultural Superintendent, viz.:

"The darkening of the juice is principally due to oxidation, and takes place rapidly at ordinary temperatures when exposed to air; it is accelerated by the presence of small amounts of copper and, less so, of iron. The absence of scum probably favours oxidation. The presence

of scum is probably due to yeast fermentation whereby air in the juice is replaced by carbon dioxide; and the scum serves to prevent surface oxidation by reducing contact with the air.

"It is suggested that air be eliminated from the juice by evacuating before storage, by filling the container from the bottom and the use of an airtight seal. Or the removal of air by blowing carbon dioxide through the juice as stored, or evacuation in storage, and the covering of the juice with a layer of tasteless mineral oil as an air seal. Finally, the elimination of heavy metals, especially copper, is reiterated, in order to reduce the oxidation reaction."

**Trinidad.**—In connection with the work of the Department of Agriculture for the half-year ended June 30, 1929, the Acting Director of Agriculture has furnished a copy of a paper published in *Tropical Agriculture, W. Indies* (1929, 6, 187), by Mr. R. O. Williams, Superintendent of the Royal Botanic Gardens and Assistant Botanist, giving a summary of work done by the Department in attempting to procure a satisfactory substitute for the West Indian lime owing to the susceptibility of the latter to wither tip disease. In Trinidad wither tip disease, first noticed in 1917, has been largely responsible for the subsequent reduction in the exports of lime products. As a first step introductions were made from the Philippine Islands, Hawaii and Burma of plants which might be of value. None of these, however, after they had reached the fruiting stage proved fully satisfactory. The Rangpur lime, although resistant to wither tip, is susceptible to gummosis and scab; its fruits do not drop when ripe. *Citrus hystrix*, of which four varieties were tested, is also unsuitable for various reasons.

*Citrus excelsa* was very early attacked by die-back and root disease; its citric acid content is very low. The Kusai lime is resistant to wither tip, but susceptible to gummosis and scab; the fruits resemble a tangerine and have not the aroma of the lime. A Burma lime very closely resembles the West Indian lime and, like it, is susceptible to wither tip. The most interesting of the introductions are some varieties of *Citrus aurantifolia* received from the Philippines. One, distinguished as P. I. 3670, proved to be apparently the same as the well-known spineless lime. Another, "Everglade," P. I. 3669, is very like the West Indian lime, but bears larger clusters of fruits. It is, however, highly susceptible to wither tip.

The third variety, *C. aurantifolia*, P. I. 2182, was the

only one of the introductions which seemed likely to be even a possible substitute for the W. I. lime. Its fruits are rather lacking in juice, the citric acid content is comparatively low, and the essential oil approximates more closely to the lemon than to the lime. It is, however, highly resistant to wither tip disease. None of the introductions having proved suitable it was determined to endeavour to produce a better plant by breeding. Crosses were made between the West Indian lime and *Citrus aurantifolia*, P. I. 2182, the most promising of the introductions.

Particulars are given of the characteristics of the resulting progeny after they had fruited. When the W. I. lime was used as the male parent all the progeny resembled the female parent P. I. 2182, and have been discarded. With the other cross, using P. I. 2182 as the male parent, some of the progeny resemble the W. I. lime, including high susceptibility to wither tip; others resemble *C. aurantifolia* and are resistant; a small third group have characters intermediate between the two parents.

One of the latter, now known as Trinidad hybrid No. 1, is of promise. So far as known it resists wither tip conveyed either by natural infection or artificial inoculation. In several other characters it comes more or less midway between its two parents as shown below from determinations by Prof. F. Hardy :

	Parents.		Hybrid.
	Female. W. I. Lime	Male. <i>Citrus</i> <i>aurantifolia</i> , P. I. 2182.	Trinidad Hybrid No. 1.
Average weight of a fruit (grams)	44.5	76.9	56.1
Average specific gravity . . .	1.048	0.908	0.980
Juice in fruit <i>per cent.</i>	47.2	34.7	43.5
Citric acid (oz. per gallon juice) .	9.90	8.80	9.37
Odour of essential oil . . .	Lime	Lemon	Lime
Reaction to wither tip . . .	Susceptible	Resistant	Resistant

The new hybrid has been propagated by budding to enable field trials to be made of its capabilities, not only in Trinidad but also in Dominica. The resistant hybrids already obtained have more recently been back-crossed with the West Indian lime. The resultant seedlings have not yet reached fruiting age.

Mr. Williams summarises the position thus :

(1) Wither tip disease has been the cause of severe losses in the lime industry in the West Indian islands.

(2) Palliative methods are not a practical means of control.

(3) Plant introduction has failed to furnish a lime with the required characteristics.

(4) P. I. No. 2182 crossed with the West Indian lime has given interesting results and Trinidad Hybrid No. 1 shows promise of commercial value.

## FODDERS

### *Beans*

**Nigeria.**—The Acting Assistant Director, Northern Provinces, reports that a number of introduced legumes are being grown in replicated rows this year in the hopes of finding one that will be worth growing for fodder, or for export beans, or both combined. These thirty-three varieties include Lima beans and Soyas from the U.S.A., and Madagascar, Ohtenashi and Danubian beans supplied by the Imperial Institute as a substitute for Lima.

As regards Lima beans for export (fodder as a secondary consideration) fifteen single plants have been selected from the mixed population grown last year, selection being based on yield, appearance of beans and boiling tests. These beans have been planted wide-spaced (with poles) in replicated rows.

## OILS AND OIL SEEDS

### *Chaulmoogra Oil*

**Federated Malay States.**—The Acting Agriculturist reports that fruiting records from a number of trees of *Hydnocarpus anthelmintica* indicate that the main crop of fruits ripen during the periods February/April and September/November, particularly the former.

The Acting Agricultural Chemist records the results of an investigation into the oil content of the seeds of the *H. anthelmintica* from the Government Experimental Plantation, Serdang, together with details of the physical and chemical characteristics of the oil. These results were published in the *Malayan Agricultural Journal*, No. 6, June 1929.

**Uganda.**—The following note on the experimental cultivation of *Hydnocarpus Wightiana* is contained in the report of the work of the Serere Plantation for the six months ended June 30, 1929.

All three plants which are standing, from a batch of seven which germinated out of 330 seeds sown in September

1925, and now about 5 ft. 8 in. in height, commenced to flower slightly during the early part of June, but have failed to set fruits up to date, all flowers having fallen off.

An attempt was made to propagate this plant from cuttings taken from basal shoots but without success, white ants being in evidence.

Similar shoots are being encouraged around the base of one plant with a view to layering.

### *Coconuts*

**Ceylon.**—The Acting Plant Pest Inspector, Southern Division, states that the Black Beetle (*Oryctes rhinoceros*) and Red Weevil (*Rhynchophorus ferrugineus*) continue to be the only important pests of coconuts in the division. The former, while being common, is less serious, but the latter, though not widely prevalent, causes great losses. It has been found that Red Weevil is generally confined to the stems of young palms, while the crowns at any age are rarely attacked unless previous damage of a serious nature has been caused by Black Beetle, "Bud rot" organisms or lightning. Black Beetle is only confined to the crowns of palms and in severe attacks decay may result following the accumulation of water during rainy weather in the damaged crown. The use of grass piles as traps for the control of Black Beetle is suggested, while the stems of fresh kitul palms (*Caryota urens*) halved longitudinally and filled up are suitable traps for the Red Weevil.

In the North-western Division the Black Beetle is widely prevalent, serious damage in a few limited localities being chiefly due to burying organic matter and coconut branches in trenches, especially on porous and sandy soils. Red Weevil is widely distributed and somewhat on the increase, owing to numerous young plantations that are coming up.

In the Central Division, according to the report of the Inspector of Plant Pests and Diseases, *Rhynchophorus ferrugineus* is the most serious pest in young palms. *Oryctes rhinoceros* is present throughout the division, but the damage done by this insect is not as serious as that of the former. *Nephantis serinapa* Meyr. occurs here and there in the foot-hills in the Kegalle district. The above insects are pests declared as such under the Plant Protection Ordinance and consequently receive close attention. Bud-rot is present but not prevalent in the division. The tree-living form of the rat *Rattus rattus kandianus* continues unabated and is responsible for a large proportion of so-called "nut fall."

Mr. M. Park, the Acting Mycologist to the Department of Agriculture, reports that the study of tapering disease of coconuts has been continued and evidence indicates that conditions combined with inherent characteristics of individual palms are largely responsible for the disease. Examples in which the degeneration can be attributed definitely to the sole action of root fungi are rare. The inoculation experiments carried out on young and mature palms have given negative results to date.

**Federated Malay States.**—In the Half-yearly Report of the Department of Agriculture for the period ending June 30, 1929, supplied to the Imperial Institute by the Director of Agriculture, the Acting Economic Botanist, Mr. W. N. Sands, reports that hybridisation experiments with different races of dwarf coconuts and "dwarfs" and "talls" was commenced. The usual routine work connected with individual palm yields and manurial experiments was continued. Further work included the collection of large numbers of coconuts from individual palms, whose fruiting records over a series of years are known, and samples of copra were prepared from them for analysis. In reporting on the latter investigation, the Acting Agricultural Chemist, Mr. C. D. V. Georgi, points out that some 450 determinations of oil content have been made, but this is considered too small a number to enable definite deductions to be drawn on account of the possible effects of seasonal variations.

Mr. Georgi also reports that routine analysis of average samples of copra from selected estates on the West Coast of Malaya indicates that the present average oil content of the estate product, calculated on a moisture-free basis, lies between 65.5 and 66 per cent. The full results of this investigation will be published later.

The Acting Government Entomologist, Mr. N. C. E. Miller, reports that *Setora nitens* Walk. is one of the chief lepidopterous pests of coconuts. In the larval stage, this insect is capable of causing considerable defoliation if unchecked. As a result of recent studies, apparently successful control measures have been recommended, at least in one district where this pest was on the increase.

**St. Lucia.**—The Agricultural Superintendent, in a report on the research conducted by the Department of Agriculture during the period January to June 1929, states that a census of all coconuts examined during 1928-29 has been drawn up for record.

The total number of trees examined was 324,062, of

which 568 (= 0.17 per cent.) were affected with disease ; of these 161 were destroyed and 119 were treated, there remaining 288 under observation.

Under the number affected with disease (568) the following incidence of disease has been observed :

Budrots . . . . .	201	Little-leaf disease . . . . .	119.
Stem bleeding disease . . . . .	7	Withering-leaf disease . . . . .	6
Leaf-yellow . . . . .	67	Bitten-leaf disease . . . . .	100
Senility . . . . .	47		

A short description of the disease and methods of treatment is being published in the *Annual Report* for 1928.

### *Ground-nuts*

**Nigeria.**—According to the Report of the Acting Assistant Director of Agriculture of the Northern Province for the half-year ended June 30, 1929, the work on this crop is divided between Kano and Zaria, selection being carried on for yield, high shelling percentage, habit and earliness. Ultimately, in reducing the number of strains to be multiplied, oil-content will be considered.

At Kano this year over forty single-plant selections have been planted in progeny rows. Most of these selections were made at Kano last season.

There has also been planted a quantity of " commercial " seed obtained from one of the more important areas where the ground-nut is grown. It is proposed to look for promising plants in this population at harvest-time.

At Zaria thirty-two single-plant selections (including spreading and erect types, some of which were obtained from Ceylon and some from Kano) have been planted in progeny rows.

New introductions have been made from Gambia, India and Bornu (Northern Nigeria). Seed of each variety has been planted both at Kano and at Zaria. It is hoped to find among these a quick-maturing variety that yields well ; a need for a ground-nut of this type is felt in Zaria, particularly as the surface soil gets hard very rapidly with the onset of the dry season.

The Mycologist to the Southern Division states that experiments designed to give some information on the viability of sclerotia of *Sclerotium Rolfsii* which were collected in July 1927 and kept in the laboratory in dry sand have been carried out. They were placed in hanging drops of water and sugar solution, but although kept under these conditions for several weeks they did not germinate. Negative results were obtained when culture media were

used and also when the sclerotia were placed in soil in contact with ground-nut plants even under conditions of excessive humidity induced by growing the plants under bell jars. Possibly the sclerotia were killed by being under completely dry conditions and that, in nature, when under alternately wet and dry conditions they may retain their viability for a longer period, as has been shown to be the case by Klebahn when experimenting with teleuto-spores of *Puccinia graminis*.

### Oil Palm

**Federated Malay States.**—The Acting Agriculturist, Government Plantations, Mr. J. N. Milsum, reports that pruning experiments have been continued and that actual harvesting records are so far in favour of minimum pruning rather than normal pruning. Normal pruning consists of the removal of all leaves up to, but exclusive of, those with fruit-bunches in their axils, while minimum pruning is the removal of such leaves as have turned yellow.

Areas have been selected on two oil palm estates in Selangor for similar manurial experiments and preliminary yields were recorded for the first half of the year. The areas selected are as follows :

Estate A.—Area—two blocks of 5 acres ; age of palms, 9 years ; soil conditions, coastal alluvial ; land flat.

Estate B.—Area—two blocks of 5 acres ; age of palms, 7 years ; soil conditions, inland quartzite ; land undulating.

The Acting Agricultural Chemist reports comparative experiments in connection with the sterilisation of both fruit and bunches, which show that a slightly increased recovery of oil is obtained as a result of sterilising the bunches under pressure previous to separation of the fruit, even allowing for the small amounts of bunch debris and undeveloped fruits which pass through the stripping machine. It appears that the increased temperature at which sterilisation is effected results in a coagulation of the mucilaginous matters, which do not therefore affect the expulsion of the oil in the centrifuge.

Results of tests with a de Laval separator demonstrated the possibility of improving the present quality of estate palm oil by the use of this machine. The moisture content of the oil can be reduced to less than 0.15 per cent., while matter in suspension should not exceed 0.01 per cent.

The chemical and physical constants of both palm oil and palm-kernel oil from different estates have been determined and the figures obtained agree favourably with those published for these oils from other sources.

The Acting Economic Botanist reports that weekly records of yields of 600 individual oil palms, together with fruit characters, are being made. A paper on variation in the character of the fruits of a number of oil palms grown under avenue conditions was published (*Malayan Agric. Journ.*, 1929, 17, 351-360).

The Mycologist (Mr. A. Sharples) reports a serious stem-rot of ten-year-old oil palms; the fungus associated with this diseased stem condition is *Fomes lamoensis*.

**Nigeria.**—Work is being carried out in the Southern Division on the extraction of the oil from the nuts. In this connection the Agricultural Chemist reports that some noteworthy progress has been made in the method of treatment of the fruits before pressing in the Culley screw press. By subjecting the mashed mass to steaming it is possible to do the initial pressing without picking out the nuts. In this way by far the greater proportion of oil is obtained in one pressing.

It has been felt that the time has come to begin active demonstration of the process to farmers and a definite start has been made in various Provinces of Nigeria, notably Abeokuta and Ondo.

It is hoped by further study in the field to improve the process still more. In some respects the labour involved is somewhat excessive. The yield of oil by this method shows an increase of over 25 per cent. over that obtained by native methods, and the quality of the oil is superior in every way to the native production.

Mention is made in the report of the Acting Assistant Director, Southern Division, that Messrs. Manlove and Watson, continuing their work in connection with suitable forms of small presses, found that although they had at last arrived at a press which they considered satisfactory, yet to obtain the best results from it involved the employment of a rather laborious method of extraction which, while it could be expected to appeal to the maker of soft oil, was not in the least likely to be adopted by the hard oil maker.

They have, however, now devised a method of extraction which is much simpler and less laborious than anything which has previously been tried and there is every prospect that it will find favour with the native extractors. If the use of the small press ever becomes general among the native extractors it will mean that between 30 and 40 per cent. of the oil in the fruit, which, under native methods of extraction, is now lost, will be saved and be available for export.

*Shea Nuts*

**Nigeria.**—The following note on the work carried out in connection with the production of shea nuts appears in the report of the Acting Assistant Director, Southern Division, for the half-year ended June 30, 1929.

A complete investigation into all the problems connected with the shea nut trade was carried out by Mr. Greenwood. The comparatively low price paid for shea kernels in Liverpool is due to the fact that they so often contain a high proportion of free fatty acid, or low proportion of oil, or sometimes a high proportion of unsaponifiable matter. Mr. Greenwood's investigations show that the high content of free fatty acids is due to only one cause, namely, the storage of the kernels after they have been removed from the nuts before they have been dried.

If this practice and also the export of germinated kernels could be prevented, then it appears that the shea kernels of the Ilorin and Niger Provinces would be consistently of satisfactory quality, and the Director estimates that if a suitable system of inspection were introduced, and the price raised as much as he thinks it could be, then the export trade from the Ilorin and Niger Provinces might be doubled.

Mr. Greenwood also found that although, judging from the size and shape of fruits, the habit of growth, etc., there are several varieties of shea trees, there appears little difference in the chemical composition of the kernels, except that kernels from the extreme North contain less oil and more unsaponifiable matter than those from farther South.

*Tung Oil*

**Ceylon.**—The Curator, Royal Botanic Gardens, Peradeniya, states that a recent consignment of seed of *Aleurites Fordii* received in fruit from the Royal Botanic Gardens, Kew, in March last germinated remarkably well, 240 strong and healthy seedlings being raised from sixty-five fruits received. The seeds were sown in a light, well-drained compost in beds protected by eaves of the store building, open to full sun but protected from rain. Growth was rapid and the majority of the seedlings have attained a height of 12 in., with eight leaves at the end of June. The germinating percentage of this consignment is outstanding and doubtless due to the seeds having been forwarded in the fruit, as against the clean seeds as hitherto.

## FIBRES

*Cotton*

**Nigeria.**—The following report of the work carried out by the Botanical Section, Northern Provinces, Nigeria, has been furnished by the Acting Assistant Director.

Anticipating that the indigenous varieties and the introduced American variety (Allen) now extensively grown here might not yield any markedly superior types under pure line selection, a number of varieties were introduced in 1928 and grown in isolated plots at Samaru. These were :

F.285}	two improved strains from India.
F.289}	
Hartsville 21 from U.S.A.	
Z.1 }	drought-resistant strains from South Africa.
U.4 }	
A.12 }	

None of these appeared markedly superior to the Allen commonly grown, except Hartsville 21, which gives promise of higher yield and stronger lint. The common complaint against Allen is its weakness. The two Indian varieties are prolific on good land, but have short and somewhat scanty lint. However, all these varieties have been planted on isolated plots again in 1929 along with the following new introductions :

Over-the-top	from French Sudan.
Mesowhite	„ Iraq.
Acala	„ U.S.A.
Cawnpore	„ French Sudan.
Cambodia	„ French Sudan.

Single-plant selections were made from Hartsville 21, A.12, U.4 and Z.1, and have been planted in progeny rows.

“D,” a pure line selected for length of lint and ginning percentage, which has been consistently valued 20–40 points higher than the commercial seed, is now being multiplied in the following stages :

1. Selfed progeny (120) of single selfed plant.
2. Isolated plot 1 acre (seed could cover 3–4 acres).
3. Isolated farm 50 acres.
4. Isolated farm 500 acres (Empire Cotton Growing Corporation).
5. Isolated area 50,000 acres (selected farmers' land).
6. General distribution.

The ginning percentage of this strain is about 2 per cent. higher than the commercial variety, but the yield per acre is slightly lower.

The seed of certain accidental hybrids, presumably Ishan-Allen, was planted here last year and gives promise of useful selections. A number of the hybrid progeny have been selected and sown this year.

The Senior Botanist reports that a series of investigations into the botanical and agronomic aspects of intercropping of cotton was commenced in 1928. A first paper on the subject will appear in the *Departmental Bulletin* for 1929. The main conclusions are as follows :

(1) Intercropping with yams results in a depression of the growth rate, yield, boll production and flower production of cotton.

(2) The extent of square and boll shedding, the weight of seed-cotton per boll and lint length appear to be unaffected by intercropping, but there is some evidence of a lowering of ginning percentage in intercropped cotton.

(3) The optimum planting date of cotton through yams during the 1928-29 season was in the neighbourhood of July 12.

The Senior Entomologist, Mr. F. D. Golding, has furnished the Imperial Institute with the following summary of three surveys at Ilorin, Badeggi and Ibadan which were completed at the end of March 1929.

(a) *Ilorin*.—Ishan A, Ilorin and Kabba cottons were grown with yams. Bacterial disease was abundant; but with the exception of cotton stainers and *Helopeltis* spp., insect pests were less numerous than in the previous season. The virus disease, leaf curl, was unimportant.

Ishan A produced a higher proportion of clean seed-cotton than Ilorin and, although its yield was less, the value of its crop was greater. The yield of Kabba compared unfavourably with those of the other varieties for the third successive year.

Soil investigations carried out by Mr. C. H. Wright on behalf of the Senior Entomologist indicated that the principal factor inhibiting yield at Ilorin is the poor quality of the soil.

(b) *Badeggi*.—Ishan A and Allen cottons were grown as sole crops on land which had been out of cultivation for many years.

Cotton stainers were about eleven times as numerous on Allen as on Ishan; bacterial disease and bollworms were prevalent on both varieties.

The boll-shedding of Ishan was abnormally high and is thought to have been due chiefly to soil desiccation and the prevalence of bacterial disease. The growth of Ishan was poor and its yield was only two-fifths as great as that of Allen, which appears to be more suited to the conditions appertaining in the Badeggi district.

(c) *Ibadan*.—Ishan A and Meko were grown through yams. Cotton stainers and bollworms were numerous. There was little difference in the susceptibility of the two cottons to these insect pests and to bacterial disease.

There were fewer Ishan plants per acre than Meko and, owing to variations in yam germination, Ishan encountered greater competition from the intercropped yams; in spite of these disadvantages Ishan gave a higher yield than Meko. The Ishan crop contained less stained seed-cotton and was worth one and three-quarter times as much as the Meko crop.

A series of experiments on the transmission of virus diseases of cotton, ground-nuts and cassava is in progress; and indications have been obtained that leaf curl of cotton can be carried by Aleurodidæ.

The Mycological Branch of the Department of Agriculture reports the results of experiments with the external disinfection of cotton seeds. The disinfection of the seeds by germisan for an attempted control of seed-borne disease, especially that caused by *Pseudomonas malvacearum*, is again being tested at Ilorin, Northern Nigeria, as the first experiment gave inconclusive results. According to Mr. G. H. Jones's estimates of the amount of disease present, there was a marked reduction of damage on cotton plants from treated seed, but on analysing the yields there was no significant increase in the amount of cotton produced by the treated plants. This is the more remarkable as Mr. Golding's results on cotton in the same district and during the same season show *Pseudomonas malvacearum* to be the most important boll-shedding factor. The experiment is being repeated, using screens of guinea corn one chain wide, i.e. twice the width of those used last year.

**Uganda**.—Mr. P. Chandler, Manager of the Serere Plantation, has furnished the summary given below relating to the work carried out during the past season and to experiments at present in progress. As in previous reports, only "bulk increase" or maincrop plots are referred to, all other work being done in connection with cotton coming under the direct control of the Cotton Botanist.

1928-29 *Season*.—The past season was of short duration compared with some, 102 days as compared with 128 days the previous season. Final pickings were made on February 12 of this year. The yield obtained averaged 459 lb. of seed-cotton per acre over the thirty-four acres. Of the various sowings, that made on June 19 at a spacing distance of 4 ft.  $\times$  2 ft. (5 acres) did best, yielding at the rate of 609 lb. per acre.

The results obtained as a whole can be regarded as very satisfactory taking everything into consideration, including a very dry latter half of the year, and the fact that a fair quantity of the "black-arm" form of *Bacterium malvacearum* was present all through. Most of the seed derived from this crop has been distributed in the Mulondo district of Teso, a new segregated area, for large-scale increase work.

1929-30 *Season*.—A selection under No. 27 is being grown this year, forming the bulk increase crop. Similar to selection No. 29 of last year it has been growing here since 1924, but coming from Nyasaland type No. 10 instead of Nyasaland No. 13.

Thirty acres are anticipated in three ten-acre blocks, Blocks Nos. 3, 5 and 8 of old area. In each of these blocks cotton will follow a different rotation as follows. Block No. 3 will follow maize, No. 5 simsim, and No. 8 a green manure crop, *Dolichos Lablab*. The latter block was sown with a seed rate of 200 lb. to the ten acres and ploughed in early June. This is the first block to be sown, the others not being ready until the respective crops are harvested.

Sowing commenced on June 28, a rather later date than was originally intended, but unavoidable on account of a very dry June month, hardly any rain falling between the first week and the date mentioned, 1.98 in. being recorded during the first week out of a total of 3.24 in. for the month. Ten acres were sown during the 28th and 29th. The spacing distance adopted is the Uganda standard, viz. 4 ft.  $\times$  1½ ft.

In sowing, economy of seed must necessarily be studied and two seeds per hole only are planted. At this rate 3¼ lb. will sow an acre, it being calculated that fully 4,540 seeds of this strain go to the pound.

Germination up to the time of writing has been rather poor, and calculating on the number of blanks filled eleven days from the sowing dates where no seedlings were visible, it was approximately 59 per cent. only. There are, however, in addition, many places where only one seedling came up from two seeds sown.

The following brief report on the work of the Serere experimental station, for the season 1928-29, has been furnished by the Director of Agriculture in the absence of Mr. Nye, the Cotton Botanist, who is on leave.

Another dry season was experienced, the total rainfall for the twelve months being 10.23 in. under the average.

Several promising strains showed up in the progeny rows, the re-selections from SG 27 being the best.

Four small bulk increase plots of SG 27, SG 23.8, SG 7, and B 1 respectively were grown. The strain B 1 gave the longest lint and the highest lint index.

The main bulk increase consisted of the strain SG 29, 34 acres being sown at Serere and 24 at Simsa. (That grown at Simsa was 2 mm. shorter than that at Serere.) The seed from both plantations is being grown in the Mulondo Segregated Area in the coming season. About 500 acres are hoped for in this area, and this will give enough seed to plant about 7,000 acres in the 1930-31 season. In the scheme introduced by Mr. G. F. Clay, Senior Agricultural Officer, the Eastern Province is to be divided up into eight units of approximately equal acreage; the 7,000 acres following Mulondo should give ample seed to plant up one of these eight units. Each unit will receive new seed every eight years. This is the first up-to-date system of seed propagation, with proper control, to be tried in Uganda, and it is to be hoped that the scheme may achieve the success it deserves.

The sowing date and spacing trial conducted at Serere again emphasised the value of early sowing. It is interesting to note that there is a greater difference of yield between the earliest and latest plantings than there is between any of the varieties grown in the variety trials.

No significance was obtained between the different spacings in this trial, but this was due in all probability to the great soil differences.

The variety trial at Serere showed no significance between N 17, N 19 and SG 29; or between SG 7 and SG 15. The first three were significantly higher yielders than the last two. SG 7 showed a significantly higher percentage of fifti (2nd Quality Cotton) than the other varieties; it is difficult to find a reason for this.

In variety trials conducted at ten different centres, no difference was obtained between SG 29 and N 17.

Spacing trials were carried out at six centres, and in every case 3 ft.  $\times$  1 ft. spacing gave a higher yield than 4 ft.  $\times$  2 ft., although the difference was statistically significant in only two cases.

Samples of the 1928-29 cottons were submitted to

brokers and spinners. The brokers' reports were quite encouraging, although the same cannot be said of those received from the spinners.

SG 27 was quoted by the brokers at 241 points on as compared with American Strict Middling; N 17 at 116 points on and SG 29 at 141 points on; this makes SG 29 £5 better per bale than N 17. SG 23·8 was quoted at 96 on, SG 7 at 86 on, B 1 at 76 on, and SG 26 at 9 points off. This latter quotation was thoroughly borne out by the spinners, as it appeared to be shockingly bad.

The best strains according to the spinning tests were N 17, SG 27, SG 29 and SG 23·8; the last-named seems to be the best. The main crop at Serere this year is SG 27, so the Mulondo Area will be planted with this strain in the 1930-31 season.

On the whole the spinners' reports were very discouraging, but it is obvious that the season was the prime cause of these bad results. Only SG 27 was quoted as " Strong " by the brokers.

The results of experimental work at the Bakalata Plantation for the six months ended June, 1929, are given below. Details of these experiments appear in the half-yearly reports for the six months ended June 30, 1928, and December 31, 1928.

*Experiment to compare the effect of interplanting with cotton a leguminous food crop and the rotating of cotton with the same food crop.*

	Total yields.
Cotton following beans . . .	184 lb.
Cotton interplanted beans . . .	179 "
	Mean of 10 subplots.
Cotton following beans . . .	18·45 lb.
Cotton interplanted beans . . .	17·9 "
No significant difference.	

*Experiment to test the effect of lime alone and in conjunction with green manure upon the cotton crop.*

	Yields.	
Control . . . . .	158·46 lb.	Mean 26·46 lb.
Lime and green manure . . . . .	123·45 "	" 20·57 "
Lime only . . . . .	140·01 "	" 23·33 "
Standard error of mean difference: 2·37.		

*Experiment to determine the relative exhaustive effect on the soil of five common native food crops, as measured by the succeeding cotton crop.*

	Yields.	
Cotton after beans . .	72.75 lb.	Mean 14.60 lb.
Cotton after potatoes . .	82.92 „	„ 16.16 „
Cotton after maize . .	76.18 „	„ 15.2 „
Cotton after ground-nuts . .	72.63 „	„ 14.50 „
Cotton after simsim . .	76.49 „	„ 15.3 „
S.E.M.D.: 1.64. No significance.		

*Experiment to determine the optimum sowing date and spacing for cotton.*

	Yields.	4 × 2. lb.	4 × 1. lb.	3 × 2. lb.	3 × 1. lb.
Planted July 15 . .		85.66	88.00	78.69	95.72
„ July 31 . .		88.34	76.57	77.70	95.49
„ August 31 . .		43.63	55.04	48.62	59.01

These results give no significant difference between the mean yields from each of the spacings at all sowing dates, but at all spacings July-sown cotton gives a significant increase over cotton planted in August.

#### *Cotton Variety Trial.*

	Yields.	
Variety : Local	85.7 lb.	Mean 17.14 lb.
S.G. 29	91.6 „	„ 18.38 „
S.G. 26	74.75 „	„ 14.95 „
S.G. 15	65.35 „	„ 13.07 „
S.E.M.D.: 0.88.		

In addition to the experiments recorded above, selection work and cultural experiments mentioned in previous reports are being continued.

#### *Sisal*

**Ceylon.**—According to Mr. W. P. A. Cooke, the Divisional Agricultural Officer, Northern Division, sisal is cultivated at Anuradhapura. At present the area under sisal is 22 acres, but only 8 acres are cropped as the others are newly replanted. An average of  $\frac{1}{2}$  ton of fibre is obtained from one acre per year. The cultivation of this crop appears to be popular, as there is a lot of demand for bulbils from the Mannar district and North-Central Province.

**Uganda.**—Mr. P. Chandler, the Manager of the Serere Plantation, states that a small area only of sisal is under this crop, odd plots of gravelly soil having been planted up from time to time; the crop has done very well.

A good many plants  $3\frac{1}{2}$  to 4 years old are now flowering. Plants which flowered previously have provided good poles from the old flower spikes for building purposes.

Rope and string making is carried on by two or three men, at intervals as material is available, to supply the needs of the plantation in ropes, and for many minor uses.

*Sugar Palm Fibre*

**Federated Malay States.**—According to a report received from the Director of Agriculture for the half-yearly period ending June 30, 1929, samples of fibre were collected from sugar palms, *Arenga saccharifera*, grown at the Government Experiment Station, Serdang, and cleaned and prepared for despatch for reports as to its market possibilities. The fibre is extensively used in Malaya for rope-making and other uses. Owing to the resistant qualities of the fibre to the action of salt water, it is used by native fishermen as leaders of fishing nets, and for anchor and mooring lines.

## RUBBER

*Jelutong*

**Federated Malay States.**—The Acting Agricultural Chemist reports the publication of the results (*Malayan Agricultural Journal*, Vol. XVII, No. 5, May 1929) of an investigation regarding the effects of the addition of iron salts to the material at various stages of its preparation. There appears little doubt that one of the principal causes of oxidation of the product is the presence of traces of iron in the latex before coagulation.

Variations have been found in the proportions of the constituents of jelutong latex from different parts of Malaya (see *Malayan Agricultural Journal*, Vol. XVII, No. 5, May 1929).

The results of experiments show that finely creped jelutong has no tendency to become brittle when exposed to the air for six months, provided there has been no contamination of the latex with metallic salts before coagulation.

## TOBACCO

**Ceylon.**—The Divisional Agricultural Officer, Northern Division, reports that the trial of tobacco as an unirrigated crop was continued. The crop maintained its superiority regarding quality, colour and burning. The planting date most suited for dry cultivation for this year was the third week in November. In other years December appeared to be the best month. Application of single, double and triple doses of complete fertiliser (1 cwt. nitrate of soda, 2 cwt. superphosphate and 200 lb. sulphate of potash forming a single dose) resulted in a yield of 320 lb., 404 lb. and 476 lb. respectively.

**Uganda.**—The Manager, Serere Plantation, states that 592 lb. of air-cured leaf were harvested from the three-

quarter acre plot, in about equal proportions of the two varieties Blue and Hickory Pryor, 287 lb. from the former and 316 lb. from the latter. Blue Pryor suffered most from the "Black Shank" disease, which in all probability accounts for the reduced yield, in spite of it being the heavier leaf variety of the two.

## DRUGS

### *Cinchona*

**Federated Malay States.**—The Acting Agriculturist, Government Plantations, reports that samples of bark from 3-year-old trees of *C. ledgeriana* growing at 4,800 ft. elevation at the Experiment Station, Tanah Rata, Cameron's Highlands, was submitted for report to the Superintendent of Cinchona Cultivation, Bengal. The report is as follows: "The samples of bark from the F.M.S. were not large enough to test separately, in fact, not large enough for a very accurate analysis even when all mixed together. But the result I have obtained is 6.6 per cent. of quinine sulphate and no appreciable amount of cinchonidine, a very nice bark."

## MISCELLANEOUS AGRICULTURAL PRODUCTS

### *Tuba Root (Derris spp.)*

**Federated Malay States.**—The Acting Agricultural Chemist reports the results of experiments showing in *Derris elliptica* a definite reduction in the amount of ether extract when the roots are allowed to remain for 25 months before harvesting. The roots should therefore be collected between 21 and 23 months after planting. Preliminary experiments with *D. malaccensis* (Erect Sarawak) show that the amount of ether extract from this variety of Derris is greatly in excess of that from *D. elliptica*, the comparative figures for five roots of the same age (23 months), calculated on a moisture-free basis, being as follows:

	Per cent.
<i>D. elliptica</i> . . . .	9.7
<i>D. malaccensis</i> . . . .	34.2

## MINERAL RESOURCES

### CYPRUS

The Imperial Institute has received from the Colonial Secretary, Cyprus, the following particulars regarding the output of minerals during the first six months of 1929.

The following statistics refer to the work done at the Skouriotissa pyrites mine of the Cyprus Mines Corporation during the first half of 1929, as compared with the first half of 1928 :

	1st 6 months, 1929.	1st 6 months, 1928.
Tonnage mined . . . . .	175,654	117,570
Mining operating labour (average per day) . . . . .	1,189	1,046
Tonnage exported . . . . .	144,855	114,895
Total surface and underground labour (average per day) . . . . .	1,590	1,378

The following are statistics relating to development at the Mavrovouni pyrites mine of the Cyprus Mines Corporation during the six months under review as compared with figures for the corresponding period of 1928.

	1st 6 months, 1929.	1st 6 months, 1928.
Boreholes, footage sunk . . . . .	2,713	3,544
" labour (average per day) . . . . .	22	31
Shafts, footage sunk . . . . .	—	216
" labour (average per day) . . . . .	9	20
Main adit, footage driven . . . . .	9,022	1,554
" " labour (average per day) . . . . .	285	61

The following statistics refer to the work of the Cyprus Asbestos Company, Ltd., for the first six months of 1929 as compared with the corresponding period of 1928 :

	1st 6 months, 1929.	1st 6 months, 1928.
Tonnage mined (rock) . . . . .	762,961	796,769
" treated . . . . .	146,820	146,994
" exported (asbestos) . . . . .	6,600	3,661
Average daily labour . . . . .	3,020	3,295

The following table shows the output of minerals, other than those dealt with above, during the six months under review as compared with the corresponding period in 1928 :

	1st 6 months, 1929.	1st 6 months, 1928.
	Tons.	Tons.
Chrome . . . . .	120	—
Terra umbra . . . . .	3,164	2,341
Gypsum, stone . . . . .	140	195
Gypsum, calcined . . . . .	5,985	4,950

### GOLD COAST

The Imperial Institute has received from Sir Albert Kitson, Director of the Gold Coast Geological Survey, the following report of the research work on raw materials carried out by the officers of the Survey during the half-year ending June 30, 1929.

The following discoveries were made :

*Iron Ore.*—Large quantities of this ore were discovered by the Director west of and near Pudo (Lawra-Tumu District, Northern Territories)—a deposit different from

that found by him south of Pudo in 1927. Further large deposits at Shiene (east of Yendi, Eastern Dagomba District, Northern Territories), on the eastern boundary of Togoland under British Mandate, were reported by Capt. W. E. Gilbert, M.C., the District Commissioner, Yendi, and were examined and reported on by Dr. Cooper. In addition to these deposits, occurrences of poor ore were found by the Director near Anum (Volta River District, Eastern Province), near Kpeve, and near Leklebi Dafo (Ho District, Eastern Province).

The Pudo and Shiene ores have been analysed by the Imperial Institute, the analyses being as follows :

*Analyses of Iron Ores, Gold Coast*

*Note.*—The figures below are the results of analyses of bulk samples.

		Pudo-Basisan track.	Locality. Pudo range.			Shiene.
			19732.	197333.	19734.	
			Per cent.	Per cent.	Per cent.	
Iron . . .	Fe	57.46	55.68	59.16	58.35	48.73
Silica. . .	SiO <sub>2</sub>	1.64	3.12	3.07	1.34	22.62
Manganese oxide.	MnO	0.42	0.11	nil	nil	trace
Titanium oxide. .	TiO <sub>2</sub>	11.06	9.2	8.40	10.84	0.21
Titanium	Ti	(6.63)	(5.44)	(5.04)	(6.50)	—
Sulphur . . .	S	0.01	0.11	0.04	0.06	0.01
Phosphorus . . .	P	trace	nil	trace	nil	0.13
Alumina . . .	Al <sub>2</sub> O <sub>3</sub>	2.12	n.d.	n.d.	n.d.	4.65

The Pudo ore has a good percentage of iron, but is rather too high in titanium dioxide to be suitable for smelting under methods at present in general use. With regard to the Shiene ore, it is unlikely that such material could be marketed in the United Kingdom or on the Continent at remunerative prices in competition with ores of much lower silica content now available in large quantities. It may, of course, be of value in the future.

Limonite of good grade was observed by Mr. O. A. L. Whitelaw along the range between Akwadum, Insuta and Masi, east of Prestea (Western Province). It is of no economic importance.

*Gold.*—Both the high and low terrace gravels of the Pra River (Western Province) were found by Dr. Cooper to contain a little gold. At some places they might be profitably worked. A company is actively testing the area.

The Director found a little gold by panning tests at a reef in the Ofin River Rubber Plantation, Dunkwa (Eastern Province), and Mr. Whitelaw discovered another fairly auriferous reef north-east of Dunkwa.

*Diamonds.*—Very small diamonds were found by Dr. Cooper to occur sporadically in both high and low level gravels of the Pra River, these stones, presumably, having been contributed to the Pra River by its tributary, the Birrim.

*Manganese.*—A little manganese ore of poor to fair quality was noted by Mr. Whitelaw on the range between Akwadum, Insuta and Masi (south of Prestea, Western Province).

*Copper.*—Copper-carbonate-bearing garnet-stauroelite-hornblende-gneiss was found by Mr. Frank Oates at several places in the Eastern Plains, particularly between Adakpui and Avegamu, at 1.2 miles, and on the track-crossing over the Aiwa River, between Fanchirinko and Agotive. The occurrences are similar to those found by Dr. Teale west of Amedika, on the Kpong road. Though interesting, these occurrences, as seen, are of no economic value, but further investigation of them is desirable when opportunity occurs.

*Chromium.*—Pieces of chromite, associated with a little limonite, were found by the Director on the Anum-Kpong road, near Anum (Volta River District, Eastern Province). An analysis of this is to be made by the Imperial Institute, and the occurrence further examined during the coming tour.

*Limestone.*—On the track between Sekwe and Kunduli, at 4.4 miles from Sekwe (Western Dagomba District, Northern Territories), a considerable deposit of thin-bedded limestones was found by Mr. Oates. A sample is to be analysed by the Imperial Institute to ascertain if it is worth further examination as a source of lime. It probably has an agricultural value. At several other places in the Northern Territories calcareous shales were noted. These are useful, from the agricultural point of view.

## UGANDA

The Imperial Institute has received from Mr. W. C. Simmons, the Acting Director of the Geological Survey of Uganda, the following report of the work done by the Survey during the half-year ending June 30, 1929.

Geological maps of the Ankole and Kigezi tin-bearing area have been prepared by Mr. A. D. Combe. These are now in the press and should be of considerable assistance to prospectors in the search for deposits of cassiterite. The memoir on this area is in course of preparation. Preliminary descriptions of the rocks and associated mineral deposits will be published in the Annual Report

for 1928. Short descriptions of some of the Bufumbira lavas will also be found in that report. A memoir on these rocks is in course of preparation, and this is to include petrographic descriptions by Mr. Simmons. The discovery by Mr. Combe of what appears to be a glacial boulder deposit round the foothills of Sabinyo, which is the most ancient of the volcanoes, is important.

A rapid visit was made by Mr. Simmons, with Mr. A. Beeby Thompson, to Lake Albert where some of the petroliferous Tertiary deposits at Kaiso were examined, and the hot salt spring at Kibero and the oil seepage on the shores of the lake were visited. The hot water of the spring appeared to be issuing in greater volume than when visited by Mr. Simmons in 1919, and there was also apparently a larger quantity of gas bubbling up through the water, and at this visit they had the good fortune to see a few drops of a light oil come up with the gas from below, spreading out as a film on the hot steaming water, and soon evaporating off. Owing to the periodic rise and fall of the water of Lake Albert (about an eleven-year cycle with seasonal lesser variations), the oil seepage at the edge is sometimes easy of access and sometimes covered by the breaking waves. It was only partly visible in April of 1929. A visit was also made to the Soroti district where preliminary drilling with light core drills, with a view to forming clearer ideas as to the possibility of winning underground water by drilled wells, was in progress. Several other localities where water problems are acute were visited. The possibility of increasing the supply of permanent water in some parts of the Protectorate is being considered, particularly because periodic droughts lead to the ill health of the native population, and cause peoples to migrate to centres where there are permanent supplies, and to move their cattle to them, so that the spreading of disease through the crowding of population and the mingling of their herds leads to much distress which, it is hoped, will be prevented when further wells are provided.

Some time was also spent by Mr. Simmons in the neighbourhood of Kampala searching for suitable materials for brickmaking, and advantage was taken of a large cutting being made at Jinja for the new railway to study the geological sections exposed. These cuttings show the weathering under tropical conditions of a dolerite which in places has been previously metamorphosed to an amphibolite.

Mr. S. Gill, the Drilling Engineer, has been occupied in the Usuku area of the Soroti (Teso) district drilling

with portable core drills as a preliminary to a larger water-boring programme with heavier drills. The information obtained will be very helpful in choosing well sites.

The laboratory work includes the usual identification and assay of specimens sent in to the office by the public and geologists in the field. The number of specimens reported on was 146. Greater progress is now being made with the work of cutting microscope sections of Uganda rocks, and in the examination and description of them. During this period samples of low-grade graphite ore from Kigarobya (Bunyoro) have been tested for the yield of graphite, a large number of concentrates have been microscopically examined. Many assorted specimens brought in by native prospectors have been named, and instructions for further work given to them. Among the last a quantity of muscovite with flakes up to 5 and 6 in. appears very promising. Several specimens of columbite have been received, not occurring so far as is known in economic quantity, but associated with cassiterite. Dr. Groves has started investigating the tin-bearing granites and the peculiar diopside, tremolite and calcite rocks associated with them. A study of the accessory minerals of the tin-bearing granites may establish criteria for the location of other deposits.

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### Tobacco

The Improvement of South African Tobacco. By W. R. Thompson. *Farming in S. Africa* (1929, **4**, 281-282).

The Characteristics and Culture of Turkish Tobacco. By G. Mills. *Cyprus Agric. Journ.* (1929, **24**, 35-37; 80-83; 103-105).

Tobacco Cutworms. By S. E. Crumb. *Tech. Bull. No. 88, U.S. Dept. Agric.* Pp. 180, 9 × 5½. (Washington, D.C.: U.S. Government Printing Office, 1929.) Price 35 cents.

La Teigne du Tabac, *Phthorimaea operculella* Zeller. By W. H. Edwards. *Bull. No. 13, Série Scientifique, Dép. de l'Agric., Île Maurice.* Pp. 8, 9½ × 6½. (Port Louis: Government Printer, 1929.)

*Drugs*

Annual Report of the Betel Vine Experiment Station Vellalur, Madras, for the Year 1928-29. Pp. 55,  $9\frac{1}{2} \times 6\frac{1}{4}$ . (Madras: Superintendent, Government Press, 1929.)

Cinchona in the Empire. Progress and Prospects of Its Cultivation. By J. M. Cowan. *Empire Forestry Journ.* (1929, 8, 45-53).

*Livestock*

Veterinary Research Report, No. 4, Department of Agriculture, New South Wales. By H. R. Seddon. *Science Bull.* No. 33, 1929. Pp. 106,  $9\frac{1}{2} \times 6$ . (Sydney: Government Printer, 1929.)

Report on the Veterinary Department, Gold Coast, for the Period April 1926-March 1927. Pp. 27,  $13 \times 8\frac{1}{4}$ . (Accra: Colonial Secretariat.) Price 2s.

Annual Report of the Ongole Cattle Farm, Chintaladevi, Madras, for the Year 1928-29. Pp. 15,  $9\frac{3}{4} \times 6$ . (Madras: Superintendent, Government Press, 1929.)

Annual Report of the Central Cattle Farm, Hosur, Madras, for 1928-29. Pp. 25,  $9\frac{3}{4} \times 6$ . (Madras: Superintendent, Government Press, 1929.)

Annual Report of the Buffalo Breeding Station, Guntur, Madras, for 1928-29. Pp. 11,  $9\frac{3}{4} \times 6\frac{1}{4}$ . (Madras: Superintendent, Government Press, 1929.)

Annual Report of the Agricultural College Dairy, Coimbatore, Madras, for the Year 1928-29. Pp. 19,  $9\frac{3}{4} \times 6\frac{1}{4}$ . (Madras: Superintendent, Government Press, 1929.)

Annual Report of the Department of Veterinary Science and Animal Husbandry, Tanganyika Territory, for the Year 1928. Pp. 44,  $13 \times 8\frac{1}{4}$ . (Dar-es-Salaam: Government Printer.) Price 3s.

Economic Aspects of the Skin and Hide Industry with Sidelights on the Cattle and Sheep Population of the World. By J. Redvers McLoughlin. *Bull.* No. 55, *Dept. Agric., Union of S. Africa.* Pp. 24,  $9\frac{1}{2} \times 6$ . (Pretoria: Government Printer, 1929.) Price 3d.

The Sheep Blow-flies of South Africa. By B. Smit. *Bull.* No. 47, *Dept. Agric., Union of S. Africa.* Pp. 27,  $9\frac{1}{2} \times 6$ . (Pretoria: Government Printer, 1929.) Price 3d.

## FORESTRY

*General*

Summary Report, Resolutions and Reports of Committees, Third British Empire Forestry Conference, Australia and New Zealand, 1928. Pp. 67,  $9\frac{1}{2} \times 6$ . (Canberra: Government Printer, 1929.)

Papers Presented at the Third British Empire Forestry Conference, Australia and New Zealand, 1928. Pp. 905,  $9\frac{1}{2} \times 6$ . (Canberra: Government Printer, 1929.)

Ninth Annual Report of the Forestry Commissioners for the Year ending September 30, 1928. Pp. 35,  $9\frac{1}{2} \times 6$ . (London: H.M. Stationery Office, 1929.) Price 9d.

Report of the Forest Products Research Board of the Department of Scientific and Industrial Research for the Period ended September 30, 1929. Pp. 71,  $9\frac{1}{2} \times 7\frac{1}{4}$ . (London: H.M. Stationery Office, 1929.) Price 3s.

First Decennial Review of the Operations of the Forests Department, Western Australia, together with the Annual Report of the Conservator of Forests for the Year ended June 30, 1929. Pp. 49,  $13 \times 8\frac{1}{2}$ . (Perth: Acting Government Printer, 1929.)

Administration Report of the Conservator of Forests, Ceylon, for 1928. Pp. 20,  $13\frac{1}{4} \times 8\frac{1}{2}$ . (Colombo: Government Record Office, 1929.) Price 45 cent..

Report of the Committee on the Commercialization of the Forest Department, Ceylon. Pp. 10,  $13\frac{1}{2} \times 8\frac{1}{2}$ . (Colombo: Government Record Office, 1929.) Price 20 cents.

Annual Report of the Forest Department, Kenya, for the Year 1928. Pp. 32,  $9\frac{1}{2} \times 6\frac{1}{2}$ . (Nairobi: Government Printer, 1929.)

Report of the Forestry Department, Gold Coast Colony, for the Year 1928-29. Pp. 11,  $13 \times 8\frac{1}{2}$ . (Accra: Government Printing Office, 1929.) Price 1s.

Annual Progress Report on Forest Administration in the Presidency of Bengal for the Year 1928. Pp. 63,  $13\frac{1}{2} \times 8\frac{1}{2}$ . (Calcutta: Bengal Secretariat Book Depot, 1928.) Price Rs. 8-1 or 13s. 6d.

Annual Report on the Forest Administration of Nigeria for the Year 1928. Pp. 29,  $13\frac{1}{2} \times 8\frac{1}{2}$ . (London: Crown Agents for the Colonies.) Price 2s. 6d.

Annual Report of the New Zealand State Forest Service for the Year ended March 31, 1929. Pp. 36,  $13 \times 8\frac{1}{2}$ . (Wellington: Government Printer, 1929.)

Annual Report of the Forest Department, North Borneo, for the Year 1928. Pp. 6,  $13\frac{1}{2} \times 8\frac{1}{2}$ .

The Eighth Annual Report of the Forest Department, Tanganyika Territory, 1928. Pp. 14,  $13 \times 8$ . (Dar-es-Salaam: Government Printer.) Price Shs. 2/50.

Administration Report of the Conservator of Forests, Trinidad and Tobago, for the Year 1928. Pp. 20,  $13\frac{1}{2} \times 8\frac{1}{2}$ . (Trinidad: Government Printer, 1929.) Price 8d.

Annual Report of the Forest Department, Uganda Protectorate, for the Year ended December 31, 1928. Pp. 8,  $13\frac{1}{2} \times 8\frac{1}{2}$ . (Entebbe: Government Printer, 1929.) Price 1s.

The Influence of Forests on Climate and Water Supply in Kenya. By J. W. Nicholson. Pamphlet No. 2, *For. Dept., Kenya*. Pp. 40,  $9\frac{1}{2} \times 6$ . (Nairobi: Conservator of Forests, 1929.)

The Regeneration of Tropical Evergreen Forests (Rain Forest). By H. G. Champion. *Indian Forester* (1929, **55**, 429-446; 480-494).

Conifera: Keys to the Genera and Species with Economic Notes. By H. M. FitzPatrick. *Sci. Proc. Roy. Dublin Soc.* (1929, **19**, 189-260).

Decay of Slash of Northern White Pine in Southern New England. By P. Spaulding. *Tech. Bull. No. 132, U.S. Dept. Agric.* Pp. 20,  $9 \times 5\frac{1}{2}$ . (Washington, D.C.: U.S. Government Printing Office, 1929.) Price 5 cents.

Yield Tables for Blue Pine (*Pinus excelsa* Wall.). By H. G. Champion, Parma Nand Suri and Ishwar Das Mahendru. *Indian Forest Records, Silviculture Series, Vol. XIII, Part X*. Pp. 29,  $8\frac{1}{2} \times 5\frac{1}{2}$ . (Calcutta: Government of India Central Publication Branch, 1929.) Price Rs. 1-9, or 2s. 6d.

The Southern Pine Beetle. By R. A. St. George and J. A. Beal. *Farmers' Bull. No. 1586, U.S. Dept. Agric.* Pp. 18,  $9\frac{1}{2} \times 5\frac{1}{2}$ . (Washington, D.C.: U.S. Government Printing Office, 1929.) Price 5 cents.

The Indian Bamboos Brought Up-to-date. By E. Blatter. *Indian Forester* (1929, **55**, 541-562).

Jets over Bamboecultuur. By S. Kalf. *De Indische Cultuuren (Teysmannia)* (1929, **14**, 647-653).

Handel en Cultuur van Rotan in de Zuider en Oosterafdeeling van Borneo. By J. H. Van Tuil. *Tectona* (1929, **22**, 695-711).

La Elaboración de Trementinas. By M. Tomeo. *Instituto Forestal de Investigaciones y Experiencias* (1929, **2**, No. 4, 136-164).

The Lumber Industry, 1927. *Forest Products Branch, Dominion Bureau of Statistics, Department of Trade and Commerce, Canada*. Pp. 85,  $9\frac{1}{2} \times 6\frac{1}{2}$ . (Ottawa: King's Printer, 1929.) Price 25 cents.

*Timbers*

British Hardwoods. Their Structure and Identification. By L. Chalk and B. J. Rendle. *Bull. No. 3, Forest Products Res., Dept. Sci. Indust. Res. and Imp. For. Inst.* Pp. 53 + 28 plates,  $9\frac{3}{4} \times 7\frac{1}{4}$ . (London: H.M. Stationery Office, 1929.) Price 5s.

The Properties and Uses of Silver-beech. By W. C. Ward. *Leaflet No. 14, New Zealand State Forest Service.* Pp. 8,  $10 \times 6$ . (Wellington: Government Printer, 1929.)

The Properties and Uses of Tawa. By W. C. Ward. *Leaflet No. 12, New Zealand State Forest Service.* Pp. 5,  $10 \times 6$ . (Wellington: Government Printer, 1929.)

Instructions for the Operation of Timber Seasoning Kilns. By S. N. Kapur. *Forest Bull. No. 72, India.* Pp. 21,  $9\frac{3}{4} \times 7\frac{1}{4}$ . (Calcutta: Government of India Central Publication Branch, 1929.) Price Re. 1'12, or 3s.

Reconditioning of Collapsed Australian Hardwoods. *Tech. Note No. 29/4, Munitions Supply Lab., Dept. of Defence, Australia.* Pp. 2,  $11\frac{3}{4} \times 8$ . (Melbourne: Government Printer, 1929.)

The Deterioration of Structures in Sea-Water. Ninth (Interim) Report of the Committee of the Institution of Civil Engineers. Pp. 69,  $9\frac{1}{2} \times 6$ . (London: H.M. Stationery Office, 1929.) Price 3s. 6d.

*Gums and Resins*

Reports of the Committee and of the Director, Indian Lac Research Institute, Nankum, Ranchi, for the Year April 1, 1928, to March 31, 1929. Pp. 32,  $9\frac{1}{2} \times 6\frac{1}{4}$ . (Calcutta: Criterion Printing Works, 1929.)

Physical Properties of Shellac Solutions. Part II. By M. Rangaswami and M. Venugopalan. *Bull. No. 2, Indian Lac Assoc.* Pp. 17,  $9\frac{1}{2} \times 7\frac{1}{2}$ . (Calcutta: Star Printing Works, 1929.)

An Investigation into the Plant Requirements of *Zizyphus Jujuba* during Growth and under Lac Cultivation. Part I. By D. Norris, M. Rangaswami, M. Venugopalan and S. Ranganathan. *Indian Forester* (1929, 55, 525-534).

*Tanning Materials*

The Tannin Content of Dead Chestnut Trees. By R. M. Nelson. *Journ. Amer. Leather Chem. Assoc.* (1929, 24, 479-499).

Mangrove Bark as a Tanning Material. By T. A. Buckley. *Malayan For. Rec. No. 7.* Pp. 40,  $10\frac{1}{2} \times 7\frac{1}{4}$ . (Kuala Lumpur: Conservator of Forests, 1929.) Price \$0.50, or 1s.

Karri Bark as a Source of Tannin. By W. E. Cohen. *Journ. Counc. Sci. Indust. Res., Australia* (1929, 2, 161-165).

Synthetische Gerbstoffe. By A. Bloemen. *Der Gerber* (1929, 55, 162-164).

## NOTICES OF RECENT LITERATURE

*Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.*

A TEXT-BOOK OF TROPICAL AGRICULTURE. By Sir Henry A. Alford Nicholls. Revised by J. H. Holland. Pp. xxxvi + 639,  $7\frac{1}{4} \times 4\frac{3}{4}$ . (London: Macmillan & Co., Ltd., 1929.) Price 15s.

The late Sir H. A. Alford Nicholls was a pioneer in tropical agriculture, both as a practical planter and as an

author. When he produced in 1892 this now well-known book, he was a medical officer in Dominica, who for some twelve years had also given attention to agriculture, with, as he said in the preface to the first edition, "no practical book that he could turn to for help in all the difficulties that were constantly cropping up in his path." In order to give to others the benefit of his experience, Dr. Nicholls wrote this volume "as a guide for the young and unlearned," and with particular reference to West Indian crops and conditions.

The new and revised edition is of much wider scope, in keeping with the great developments of tropical agriculture during nearly the last forty years. Several new sections have been added, e.g. on rubber, which was unknown as a cultivated plant in 1892, fibres, vegetable oils, etc., and others enlarged. The few illustrations of the original work have also been very largely added to, and as a result the present edition is about twice the size of the old. Appended to each chapter are references to books, etc., in which the various subjects are treated more fully, thus enhancing greatly the value of the work to the beginner, to whom it will, as of old, form a useful introduction to tropical agriculture.

The new sections give a concise account of the products with which they deal. In some of the others, however, there is much entirely obsolete matter, which could with great advantage have been omitted. This is particularly the case, for example, with Chapter V on sugar-cane. The greater portion follows the old text very closely. We are told that cane cultivation "of late" has become unprofitable owing to the increased production of bounty-fed beet sugar; that central factories are *being* introduced and *promise* to do much good; that but little attention is given to selecting good cane plants, and that if the sugar planters had taken pains to improve the quality of their canes the resulting greatly increased yield "would have preserved the industry from much of the misfortune which has come upon it"; that in British Guiana the canes contain about 15 to 18 per cent. of crystallisable sugar, but only 6 or 7 per cent. is extracted "by the best manufacturing processes . . . these figures may be taken as fair average ones for cane culture." These statements, whilst unfortunately only too true of the West Indies in 1892, are entirely misleading if read as portraying conditions there, or in any other important cane-growing country, in 1929. It is not until almost the end of the chapter that any indication is given that conditions have changed, and the brief notes then added

do not afford any adequate idea of the present position of the sugar-cane industry.

HANDBOOK FOR FARMERS IN SOUTH AFRICA. Pp. vii + 766, 9 × 6. (Pretoria : The Government Printer, 1929.) Price 5s.

This volume is issued by the South African Department of Agriculture, as a general guide to farming operations in the Union. In a prefatory note it is stated that the work is the first departmental publication of its kind, and does not claim to cover the whole range of farming, but that it is hoped that it "will be found a useful source of reference." This will undoubtedly be the case, as the volume furnishes in a clear and well-arranged manner a very large amount of instruction and information on farming matters, a considerable portion of which is of importance to farmers in general and should enable the handbook to be utilised to good purpose in other countries than South Africa.

The more specialised sections of the work deal with Feeding and Management of Livestock ; Animal Diseases and their Treatment ; Soil and Factors affecting Plant Growth ; Principal Crops of the Union, and Insect Pests and Plant Diseases ; whilst further sections are entitled Organization in Farming ; Useful Notes on Many Subjects, and The Farm Home. The book contains many useful illustrations and diagrams, and a series of maps showing the distribution of crops and livestock in the various parts of the Union.

SISAL. PRODUCTION AND PREPARATION. Edited and brought up-to-date by H. Hamel Smith. Pp. xxvii + 384. 6 × 9½. (London : John Bale, Sons & Danielsson, Ltd., 1929.) Price 21s. net.

Mr. Hamel Smith has brought together in this book a large amount of information on sisal ; together with, as mentioned on the title page, comparative notes on other fibres and on the question of Panama disease.

The mode of compilation of the book will make it difficult for the practical man, for whom it is presumably intended, to obtain a proper perspective of the industry. Thus in Part I, which deals with Production, no less than the first 137 pages, out of a total of 290, are devoted to the reproduction of previously published accounts of sisal in India and Queensland, up to 1906 and 1910 respectively. Neither of these countries now produces sisal to any considerable extent. Tanganyika, on the other hand, which

now heads the list of exporting countries in the British Empire, is dismissed in two pages, on the ground that the position of the industry is so assured that little space need be given to it. The would-be planter would surely prefer to have a detailed account of conditions and methods which are giving increasingly successful results in Tanganyika, rather than lengthy descriptions of those which have produced but little commercial result elsewhere, interesting though the latter may be historically. Still there is much valuable and recent information in the book, e.g. the account of Kenya and notes in the chapter entitled "Miscellanea," which, however, the reader must unearth and put in proper place for himself.

Part II deals with "Preparation." Accounts are given by various firms, referred to by name, of machinery and methods used in different countries. Much useful information is given, but again the would-be producer would doubtless be glad to have some independent expression of opinion on the comparative value of the various machines, etc., discussed.

The prominence given on the title page to "the question of Panama disease" of bananas is scarcely justified by the attention given to it in the book. There are some brief scattered suggestions to the effect that if waste banana stems and leaves were used for the production of power alcohol instead of being allowed to rot on the ground, the incidence of Panama disease should be materially reduced. No reference is made to the fact that the cause of Panama disease is a soil-inhabiting fungus, which occurs also in the perennial under-ground portions of the banana. In fact so slight is the author's acquaintance with the facts that he refers to the causative organism as a "bacteria pest."

The book contains many useful illustrations.

WOOL: A STUDY OF THE FIBRE. By S. G. Barker, Ph.D., Director of Research, British Research Association for the Woollen and Worsted Industries. Pp. 166, 9 $\frac{1}{2}$  × 7 $\frac{1}{4}$ . Issued by the Empire Marketing Board. (London: His Majesty's Stationery Office, 1929.) Price 1s. 6d.

The fact that wool production is one of the most important agricultural industries of the British Dominions and that the fibre constitutes the raw material of one of the greatest British manufacturing industries renders it obvious that every endeavour should be made by the breeder and sheep farmer to improve the quality of the fleece in order to obtain products well adapted to the varied needs of the manufacturer. The attainment of

this object demands an acquaintance with the physical and chemical characteristics of wool, and involves careful scientific work in order that our knowledge of these properties may be extended.

In the present publication, the author has given a detailed account of the biology of wool, of the chemical composition and characters of the fibre, and of its physical and dimensional characteristics, and under each of these headings he has clearly indicated the outstanding points on which scientific investigation is needed.

The work will be of value to wool farmers as well as to manufacturers and users, and will be of particular interest to those who have leisure and opportunity to engage in scientific research, whether biological, chemical or physical, in indicating directions in which their activities may be usefully applied.

The book is well illustrated, and a classified bibliography is appended.

BANANE. By W. Ruschmann. Pp. viii + 146,  $7 \times 4\frac{3}{4}$ . (Berlin & Leipzig : Deutscher Auslandverlag, Walter Bangert, 1929.) Price RM. 5.50.

This volume is one of the series of well-known monographs on tropical agriculture issued under the title "Wohltmann-Bücher." The author has had considerable practical experience in the cultivation of bananas, and has produced a book which should be of great value to all interested in the production of this fruit. All aspects of the question are dealt with, including the botanical characters of the plant, and its chemical composition, cultivation, harvesting, transport, and diseases and pests.

There are also short sections on the food value of the banana, the utilisation of banana fibre, and the preparation of dried bananas, banana meal and alcohol.

*Note.*—With reference to the previous volume of this series, "Ölpalme," by Dr. E. Fickendey and H. N. Blommendaal, the publishers state that the price should be RM. 7.50, and not RM. 9 as printed in the notice of the book which appeared in the last number of this BULLETIN, p. 429.

CULTURA CAFEEIRA. DO ENLEIRAMENTO PERMANENTE A PRODUÇÃO DE TYPOS FINOS. By Rogerio de Camargo. Pp. 100,  $9\frac{1}{2} \times 6\frac{1}{4}$ . (São Paulo : Secretaria da Agricultura, 1929.)

After a general prelude on the coffees of Brazil the book deals with the defects of the present system of cultivation,

and in particular with the degeneration and malformation of coffee bushes caused by too crowded planting, soil poverty, cutting of the roots during weeding, and use of concentrated manures over a too limited area. A method of bedding is recommended (*enleiramento permanente*), which consists of trenching around each bed and then filling in the trenches with organic matter so as to form ramparts around the root-system of each plant.

The author concludes with noting some common defects of coffee beans, and with instructions for the production of good quality types.

The work is fully and clearly illustrated.

COLOMBIA CAFETERA. By Diego Monsalve. Pp. 950,  $13\frac{1}{2} \times 10$ . (Artes Graficas S.A., Successors to Henrich y Cia, Calle de Corcega 348, Barcelona.)

An official publication by the Colombian Government, who intended the work to be "propaganda for the country" and published it as an edition de luxe. It contains historical, political, geographical, economic and every other kind of information about the country in general, and each department in particular.

Part III deals at length with the Colombian coffee industry, including full statistics of the coffee plantations in every department.

Part IV contains information on the oil and mineral wealth of the country, its flora, fauna, agriculture, manufactures and trade.

The whole is richly and abundantly illustrated in black and white and colour.

THE REALM OF RUBBER. By H. H. Ghosh. Pp. xiv + 252,  $9\frac{1}{2} \times 6\frac{1}{4}$ . (Calcutta: J. B. Daymond, 1928.) Price Rs. 10.

Apart from the introduction and short chapters on "Production, Trade and Restriction," "The World's Rubber Sources," "Synthetic Rubber and the Rubber Market" and "Statistics of the Industry," this book deals primarily with questions relating to the cultivation of plantation rubber. Although special chapters are devoted to the rubber growing in India and in Burma (where the author considers the prospects for immediate expansion are promising), and in another chapter certain problems connected with rubber planting in Ceylon are discussed, no information is given regarding the conditions in such important rubber-growing countries as British Malaya and the Dutch East Indies.

The volume is compiled to a very large extent from abstracts from other publications, and these are frequently neither well selected nor well arranged. It is unfortunate that in a book claiming to be a record of existing conditions in the rubber industry, erroneous impressions of present-day plantation factory practice should be given owing to indiscriminate quotations from scientific and technical books and journals which were published several years ago.

LES CACTACÉES UTILES DU MEXIQUE. By Léon Diguët. Pp. 551, 10 × 6½. (Paris: Société Nationale d'Acclimatation de France, 1928.) Price F. 120.

This book opens with a memoir by Professor D. Bois of the author, who died in 1926 after spending a large part of his life in accomplishing some seven missions to Mexico, during which he made valuable collections for the Muséum d'Histoire Naturelle at Paris, of which institution he was a "correspondent." The work, which had been prepared previous to the death of M. Diguët, is a tribute to his industry and powers of observation and provides a valuable account of those cacti which are devoted to human purposes in Mexico. The first four chapters of the book are introductory, dealing among other topics with the Mexican terminology of the cacti correlated with their botanical names, the methods of propagation, the rôle played by cacti in the occupation of the deserts, and the value of the plants as sources of water and food to natives living in or wandering through those regions. The remainder of the work is concerned with a study of the species which are utilised for practical purposes. By far the most important use of the cacti in Mexico is as a source of food, the groups concerned being *Opuntioideæ*, *Cereoideæ* (including *Cereus*, *Echinocactus*, *Melocactus*, *Mammillaria*, *Machærocereus*, etc.), which furnish large quantities of fruits serving as a valued foodstuff, while species of *Opuntia* and *Echinocactus* afford a stem pulp which has nutritive value; in all other cases it would appear that the stem pulp is unwholesome and even toxic. Cacti are also much used for hedges and enclosures, not only on account of their virtual impenetrability, but also in view of their permanence and efficacy in arresting the spread of the fires which frequently arise in the dry season. Species largely used for this purpose are *Opuntia ficus indica* Mill., *O. Tuna* Mill., *O. Cardona* Web., *Nopalea Karwinskiana* Schum., *Pere-skiopsis* spp. and *Cereus* spp. Useful fibres are yielded by several species. A soft "wool," which may serve a

similar purpose to kapok, is obtainable from species of *Cephalocereus* and *Pachycereus*, but the fibre is not yet an article of commerce largely owing to the somewhat scattered distribution of the plants from which it is derived. The seeds of a number of species form a useful substitute for cereals and yield a flour more or less suitable for bread making; the plants concerned are chiefly species of the *Opuntia* group (*Platyopuntia*), *Nopalea*, and certain *Echinocactæ*. Serviceable timber for constructional work is derived from *Opuntia* spp., *Lemaireocereus Thurberi* Britt. et Rose, *Carnegiea gigantea* Britt. et Rose, and *Pachycereus* spp. Gums are yielded by *Opuntia* spp. and *Lemaireocereus* spp. A special chapter is devoted to an account of the cacti concerned in the propagation of the cochineal insect, and there is a useful section dealing with the cultivation of cacti.

The book contains a store of valuable information and is illustrated by an exceptionally fine series of photographs.

A CRITICAL AND HISTORICAL STUDY OF THE PECTIC SUBSTANCES OF PLANTS. By M. H. Branfoot (M. H. Carré), D.I.C., D.Sc., Department of Scientific and Industrial Research Food Investigation, Special Report No. 33. Pp. x + 154, 9½ × 6. (London: His Majesty's Stationery Office, 1929.) Price 3s. 6d.

The literature hitherto available on pectins contains many contradictory statements and introduces much confusion owing to the lack of uniformity in nomenclature and to the fact that much research has been carried out on substances of doubtful purity and under non-standardised conditions. The present publication attempts to elucidate the subject and should, therefore, prove very useful to those desiring accurate information on this group of compounds.

The chapters on the chemistry of the pectic compounds deal historically with the properties and chemical constitution of pectose, pectin, pectic acid and metapectic acid. The extraction and purification of the various pectic substances are discussed, but the commercial methods of manufacturing pectin for utilisation in the confectionery trades are only briefly outlined and no information is given as to the relative merits of these methods, nor as to which of them have proved financially successful.

In connection with the botanical side of the subject a description is given of micro-chemical methods by which the pectic constituents of the plant tissues may be detected and examined and their distribution in the tissues ascertained. A chapter is devoted to the relation of the pectic

compounds of fruits to the metabolic changes which occur during ripening and senescence. The action of fungi and bacteria on pectic substances, including the fermentative changes which occur during the retting of textile fibres, is discussed. The report concludes with a résumé of the work which has been done on pectin-sugar jellies.

A useful bibliography of the literature relating to the pectic compounds is provided as an appendix to the work.

THE STRUCTURE AND LIFE OF FOREST TREES. By Dr. M. Büsgen. Third, revised and enlarged edition by Dr. E. Münch. English translation by Thomas Thomson, M.Sc. Pp. xi + 436, 9 $\frac{1}{4}$  × 6. (London : Chapman & Hall, Ltd., 1929.) Price 30s.

The hope expressed by the translator that the volume now made available by him in English will prove "a useful addition to our forest botanical literature" will doubtless be realised, for the appearance of a work in English on the subject of this volume has long been a desideratum. A primary need of the forester is an understanding of the science of botany on which his craft is founded, and a work bringing before him a comprehensive account of the aspect of botany with which he is most nearly concerned, namely, the structure and life history of forest trees, should prove a valuable aid, if he is well grounded in first principles. The subject matter will also be found to be of much interest to botanists whose work leaves them unacquainted with the advances made in forest botany as recorded in forestry literature. The present book is a translation of the third edition of the late Professor Büsgen's "Bau und Leben unserer Waldbäume" which under the editorship of Dr. E. Münch was the outcome of considerable modernisation and expansion by that authority.

The plan of the book is essentially a study of the morphology and physiology of the forest tree. Chapters are concerned with the form of the tree, the buds, leaves, roots and reproductive organs, and others are devoted to the elements of the wood and bark, the water economy of the plant and the mineral constituents of its several parts. There is also in a section dealing with the movements and transformation of substances in the body of the tree, a discussion of Münch's views regarding the circulation of the sap. The same authority, as editor of the volume, has added a new chapter on "Local Races" of trees and the factors which probably lead to their occurrence. The book is illustrated by photographs and drawings, and three useful indexes, namely, a general index, a list of authors cited, and a statement of the common names of plants.

mentioned in the text with the corresponding botanical names, add to the practical usefulness of the work.

**THE RAT : A WORLD MENACE.** By A. Moore Hogarth, F.I.S. With Preface by Sir Thomas Horder, Bart., K.C.V.O., M.D., F.R.C.P. Pp. vi + 122, 8½ × 5½. (London : John Bale, Sons & Danielsson, Ltd., 1929.) Price 7s. 6d.

The rat problem presents itself in so many different ways that there can be no "standard practice" in dealing with it, and it seems that books on the subject must to some extent be compendia of information from various sources regarding the destructiveness and disease-carrying propensities of the animal, methods used or proposed for fighting the pest, and opinions as to what the Government ought to do about it.

The present very useful publication is at least partly constructed on these lines. It includes references to legislation on the destruction of rats, a College of Pestology Gold Medal Essay, and other such diverse material as verses from *Punch*, a letter from "Helpful" to the *Daily Mail*, and the Revised Rules of the Sissinghurst and District Rat and Sparrow Club.

The chapters dealing with the different methods of combating the pest, by "ratting" with dogs, flooding and smoking, ferrets, trapping, poisons, and the use of virus, contain much useful practical information, and at the same time stress is laid on the fact that there is no "best" method, the war against rats being a battle of cunning against cunning in which a perpetual vigilance is necessary.

**INSECTS, TICKS, MITES AND VENOMOUS ANIMALS OF MEDICAL AND VETERINARY IMPORTANCE.** Part I.—Medical. By Walter Scott Patton, M.B., Ch.B., F.E.S., and Alwen M. Evans, D.Sc. Pp. x + 786, 9½ × 7½. (Croydon : H. R. Grubb, Ltd., 1929.) Obtainable for 20s. post free from the Liverpool School of Tropical Medicine, Liverpool.

This is the first of four volumes, each of which is to be complete in itself. It covers the course for the Diploma in Tropical Medicine at Liverpool University, and consists of synopses of lectures and notes of laboratory work. It could serve as a basis for similar courses at other schools and universities.

The book replaces Patton and Cragg's *Textbook of Medical Entomology*, published in 1913 and now out of print. It deals in considerable detail with the biology

of a large number of species affecting the health of man, and with the principles underlying methods of control, and will be invaluable as a work of reference for medical practitioners, particularly in the tropics, as well as a guide for research workers in a field where there is much ground awaiting exploration.

The illustrations are a particularly valuable feature of the book.

**THE MIND OF THE SAVAGE.** By Raoul Allier. Translated by Fred Rothwell. Pp. xiv + 301,  $8\frac{3}{4} \times 5\frac{1}{2}$ . (London: G. Bell & Sons, 1929.) Price 15s.

M. Raoul Allier has made a special study of the psychology and sociology of uncivilised races, and some of his most important conclusions are set out and elucidated in this readable and instructive volume.

M. Allier strongly emphasises the view that the strongly-rooted belief in magic which dominates many savage races is adverse alike to religion and material progress, and has an important bearing on European relations with such races and on efforts to civilise them. The present work should prove of considerable interest and utility to Government officers, missionaries and others whose duties bring them into close contact with primitive peoples.

**STRUCTURE AND SURFACE. A BOOK OF FIELD GEOLOGY.** By C. Barrington Brown, M.C., M.A., A.R.S.M., F.G.S., and F. Debenham, O.B.E., M.A., F.G.S. Pp. vii + 168,  $9 \times 5\frac{3}{4}$ . (London: Edward Arnold & Co., 1929.) Price 10s. 6d.

This book deals principally with the application of the perspective block diagram, or "stereogram," as a method of illustrating geological principles. Despite definite limitations, the method is undoubtedly the most natural and convincing way of showing in two dimensions what actually occurs in three, and should prove particularly interesting to the young student of structural and surface geology.

The work comprises twelve chapters dealing respectively with a general introduction to the subject, the form of rock masses, measurements in the field, surface and outcrop, folds, faults, structure of igneous rock masses, surface relief, major land forms, minor land forms, the construction of block diagrams, and block diagrams of geological maps and structures. The idea of reproducing block diagrams from chosen rectangular areas of the One

Inch Geological Survey maps has not hitherto been utilised for illustration.

The concluding section contains three useful appendices on equipment and surveying instruments, the problem of apparent dip, and the determination of differences in level ; and an interesting folding map of a dissected block diagram of England and Wales.

The work is well written and the authors are to be congratulated upon the excellent and original diagrams that accompany the text.

SEDIMENTARY PETROGRAPHY. Second Edition. By Henry B. Milner, M.A. (Cantab.), D.I.C., M.Inst.P.T. Pp. xxi + 514, 7 $\frac{1}{4}$   $\times$  5. (London : Thomas Murby & Co., 1929.) Price 21s. net.

This work, whilst embodying certain portions of the original volume (1922), and much of the supplement (1926), together with portions from *Alluvial Prospecting* by C. Raeburn and the present author (1927), has been completely revised and brought up-to-date by the incorporation of much new matter.

Additions have been made to the introduction, to discussions on samples, storage and records, and also in connection with laboratory technique (Chapters I-III). Two new chapters (IV and V) deal respectively with the microscopical examination of sediments and the quantitative aspect of the subject. Chapter VI, comprising 147 pages, and representing more than a quarter of the text, is devoted to a systematic description of the diagnostic properties of sedimentary rock minerals, whilst in Chapter VII conventional sedimentary rock-types are described and defined on the genetic basis of classification. The principles and practice of differentiation and correlation of sediments by petrographic methods are discussed in Chapter VIII, actual examples by international workers being quoted in the following chapter. The concluding chapter (XI), on the application of sedimentary petrology to the study of soil (Pedology), is of interest in view of the extensive mineralogical research of soils now undertaken in different countries.

The work is fully annotated, well illustrated, and contains three useful appendices, including detrital mineral determination tables and a select bibliography. Of the 72 minerals described, 55 are figured ; 70 photomicrographs of thin sections of typical rocks (apart from text figures) are included ; whilst the total number of illustrations is 181, or more than double the number appearing in the previous volumes.

The work is a comprehensive treatise of the petrology of sediments of whatever character, and should prove useful to all engaged in the study of sedimentary rocks, especially in connection with sub-surface oil geology.

THE NAPPE THEORY IN THE ALPS. By Dr. Franz Heritsch, translated by P. G. H. Boswell. Pp. xxx + 228,  $7\frac{1}{2} \times 4\frac{3}{4}$ . (London, Methuen & Co., Ltd., 1929.) Price 14s.

This book is a translation of Professor Heritsch's *Die Deckentheorie in den Alpen*, which appeared in the *Fortschritte der Geologie und Paläontologie* for 1927, and constituted a review of the development of the Nappe Theory during the period 1900-1925. The English edition has, however, been brought up to date by the addition of a number of new passages, whilst many of the photographic plates and text-diagrams appear for the first time in this work.

In the opening chapter the author summarises admirably the conflicting views on Alpine correlations and declares himself an opponent of the Nappe Theory in its more extended form, denying the possibility of the application of the theory to the Eastern Alps. Discussions then follow on the rationale of the theory; its application in the Alps; the East-Alpine Nappes of Eastern Switzerland; the Silvretta, Oetzal, Adamello, and Hohe Tauern masses; the Pre-Alps and Calcareous Alps; the roots of Alpine Nappes; the Southern Alps; and date of orogenesis. The work is completed by a select bibliography and useful index.

Undoubtedly the work of the Swiss geologists is better known in English-speaking countries than that of the Austrian and Italian investigators, so that the present work, coming as it does from the pen of an eminent Austrian professor, is particularly welcome at the present time.

Professor Boswell has rendered a valuable service by his able translation, and the glossary of tectonic and stratigraphical terms (for which he alone is responsible) should prove useful to all interested in the difficult study of Alpine tectonics.

APPLIED GEOPHYSICS. By A. S. Eve, C.B.E., M.A., D.Sc., F.R.S.C., F.R.S., and D. A. Keys, M.A., Ph.D., F.R.S.C. Pp. x + 253,  $8\frac{1}{2} \times 5\frac{1}{2}$ . (Cambridge: University Press, 1929.) Price 12s. 6d.

Methods of geophysical surveying have been developed extensively during the present century, particularly during the last ten years, and already results have been so en-

couraging that, with the gaining of more experience, there is reason to think that a training in some of the methods will eventually become part of the equipment of every mining engineer and economic geologist. Already the Institute of Applied Geophysics at Göttingen, with the aid of a highly specialised staff, is entirely devoted to the studying of every branch of the art, and the world's literature on the subject is by no means inconsiderable. There is, however, plenty of room for this volume, which is up-to-date, and should be in the hands of all who are interested in the rapid location of ore bodies. Its authors are professors at McGill University, who have quite recently tested a number of the known methods of geophysical surveying in the Rocky Mountains, United States, and in Canada, where they also developed methods of their own.

All the known varieties of the magnetic, electrical, electromagnetic, gravitational, seismic and radioactive methods of survey are fully described in separate chapters in the book, in which numerous excellent illustrations and diagrams are supplied. Some mathematical knowledge is required of the reader in places; otherwise the text is very simple in spite of its technical nature. The volume is completed with a bibliography of the chief publications on applied geophysics.

The publishers have acted wisely in issuing the book at a price within the reach of students.

**ORE DEPOSITS OF MAGMATIC ORIGIN: THEIR GENESIS AND NATURAL CLASSIFICATION.** By Dr. Paul Niggli, translated from the original German edition by Dr. H. C. Boydell, M.I.M.M., revised and supplemented throughout by Dr. Niggli and Dr. R. L. Parker. Pp. xi + 93, 9 $\frac{3}{4}$  x 6 $\frac{1}{4}$ . (London: Thomas Murby & Co., 1929.) Price 9s. 6d.

This is a translation of a book by Professor P. Niggli which was originally published as Vol. I of the "Abhandlungen zur praktischen Geologie und Bergwirtschaftslehre," being based on lectures given in 1923-24 at the Swiss Federal Technical University at Zürich.

Chapter I deals with the physical chemistry of ore-generating magmas, and includes a section on the paragenesis of elements in which V. M. Goldschmidt's classification of the elements is given. In Chapter II, the minero-chemical classification of magmatic ore deposits is considered, various systems of classification being outlined and compared. Chapter III gives an account of the associations of magmatic ore deposits in relation to the earth's major structural units and rock provinces.

The views set forth by Professor Niggli in this book are

in close accord with conventional ideas on the genesis of ore deposits, and it is distinctly useful to have this English translation of a work by such an eminent European authority on mineralogy and petrology.

THE EVOLUTION OF THE IGNEOUS ROCKS. By N. L. Bowen. Pp. x + 332, 9 × 6. (Princeton, U.S.A.: Princeton University Press; London: Humphrey Milford, 1928.) Price 23s.

This is without doubt one of the most important volumes dealing with the question of petrogenesis that has yet been published. It contains little that is new, but is a presentation in collected and connected form of the author's previous contributions to the science, and is based upon a course of lectures delivered by him at Princeton University. It is in no way a text-book of petrology, but an interpretation of the facts observed in the study of igneous rock series according to the views of those who, like the author, regard them as having been derived from a basaltic magma by means of fractional crystallisation under various conditions.

The book, therefore, consists mainly of the consideration of the data obtained by the laboratory investigation of silicate melts, the equilibrium diagram furnished by the artificial systems which have been studied experimentally, and hypothetical diagrams deduced from observed mineral assemblages.

After a preliminary discussion of the problem of the diversity of igneous rock types, immiscibility in silicate magmas is considered, and the author concludes that it is impossible to explain adequately the fundamentals of petrology on this basis. Next, fractional crystallisation is discussed, and this is followed by a good account of the results obtained by the experimental study of a number of two- and three-component silicate systems, and a discussion of the reaction principle. The process of fractional crystallisation of basaltic magma is next considered, and the argument that normal sub-alkaline rock series can be derived in this manner is developed. The use of variation diagrams is discussed in the light of many examples, and their significance emphasised. This is followed by observations upon the glassy rocks and the evidence they bring to support the author's theories.

Attention is next directed to those rocks whose composition is believed to have resulted from accumulation and sorting of crystals of various kinds, the rock associations in the Scottish Hebrides being used as illustrations. The next chapter deals with the effects of assimilation, the

phenomenon being treated as a kind of corollary of crystallisation governed by the same general laws. The action of magmas on various sedimentary as well as igneous inclusions is considered in some detail.

The second part of the book is perhaps a little more speculative. Commencing with the hypothetical derivation of potash-rich magmatic liquid by fractional crystallisation, the origin of the alkaline rocks is discussed, and this is followed by a consideration of the origin of the lamprophyres. This leads to chapters on fractional resorption of complex minerals such as hornblende, the formation of strongly ferric alkaline rocks such as nepheline-, leucite- and melilite-basalts, and other effects of fractional resorption. Next, there is an important and interesting chapter on the importance of volatile constituents, which bears very considerably on the formation of deposits of economic minerals. The author admits the importance of the volatile constituents in extrusive igneous phenomena, but agrees with Vogt in the view that they are of little importance in the problem of magmatic differentiation. The volume concludes with a chapter on petrogenesis and the physics of the earth generally, and a brief word on the classification of igneous rocks in which it is claimed that the mineralogical classification at present used is a genetic and natural system.

This work is one which merits the closest attention of all who study rocks. It is remarkably well written and presented in a very forceful and confident style, but one must avoid the conclusion that the work of Bowen and his colleagues has finally solved the problem of the origin of igneous rocks, remembering that the subject remains one of considerable controversy. At the same time great credit must be given to the author for his remarkable contributions to the elucidation of the problems involved.

PRECIOUS AND SEMI-PRECIOUS STONES. By Michael Weinstein. Pp. x + 138, 8 $\frac{1}{2}$   $\times$  5 $\frac{1}{2}$ . (London: Sir Isaac Pitman & Sons, Ltd.) Price 7s. 6d. net.

Certain minerals and closely related substances have always exercised a peculiar fascination on account of their beauty, durability or rarity, and have been employed by man for personal adornment and other decorative purposes from the earliest times. Such substances have come to be known as precious and semi-precious stones, and although the popularity of individual kinds varies considerably from time to time with the dictates of fashion, they are used to a greater extent at the present time than ever in the past.

The small volume under notice makes no pretence of

being a text-book, nor of contributing anything to the already considerable scientific or artistic knowledge of precious stones. It is merely a readable account of the properties and nature of the various stones, intended for the general reader and as an incentive to the few who may wish to pursue this fascinating subject further.

The book is written in an easy style and contains a great deal of interesting matter, but there are several striking omissions. While for instance the diamond is mentioned as occurring in Southern Rhodesia, where the deposits are comparatively unimportant, there seems to be no mention of the important diamond fields of Angola and the Gold Coast. Other examples might be cited, but on the whole the book contains more information than is usually met with in such works. Except for plate 4 the illustrations are good, but perhaps too few.

THE INDUSTRIAL DEVELOPMENT OF SEARLES LAKE BRINES WITH EQUILIBRIUM DATA. By John E. Teeple, Ph.D., and Associates of the American Potash and Chemical Corporation. Pp. 182, 9 × 6. (New York: The Chemical Catalog Company, Inc., 1929.) Price \$3.00.

This book is in two parts. The first, comprising 63 pages, is of interest to the general scientific reader, and gives an account of the evolution and development of the production of potassium chloride and borax from the brine deposits of Searles Lake, California.

The subject matter opens with a description of Searles Lake, and an account of the early recovery operations, and leads to a discussion of the problems involved, and a general description, without technical details, of the plant now in operation. This portion of the book is written in a very readable and informative manner.

The second part, of 117 pages, will appeal more to the physical chemist, as it consists entirely of equilibrium data and phase rule diagrams, dealing with various complex systems of water and salts occurring in the Searles Lake brines. It forms part of the preliminary work in the development of the present process, and should be of value to those engaged in investigations of a similar nature.

SURVEYING AS PRACTISED BY CIVIL ENGINEERS AND SURVEYORS. By John Whitelaw, Jun. Eighth Edition, thoroughly revised and enlarged by Colonel Sir Gordon Risley Hearn, C.I.E., D.S.O. Pp. xv + 578, 8 × 5. (London: Crosby Lockwood & Son, 1929.) Price 16s.

The revision of the 7th edition of this well-known standard work, which appeared in 1924, has been made by

an engineer whose long and varied experience in India has amply qualified him for the work.

The book has been completely overhauled, and, in view of the great progress which has been made in survey work in the last few years, much new matter has been added to it. Its value has been largely enhanced by the large number of examples given of work done in actual practice.

The earlier chapters deal with the various surveying instruments in their modern forms, their functions, capabilities and adjustments, and the correction of errors made in working. Subsequent chapters are devoted to railway surveys, stadia surveying, tunnel alignment and setting out, surveying for water supply works, marine and river surveys, such astronomical observations as required by surveyors, and methods of survey applicable to rough or difficult and unmapped country abroad. The last chapter deals with trigonometrical or geodetic surveying, and a quantity of useful information is given in an appendix.

The book has been excellently printed and illustrated, and can be confidently recommended to all classes of surveyors, whilst its low price should specially appeal to students.

**SELECT METHODS OF METALLURGICAL ANALYSIS.** By W. A. Naish, Ph.D., A.R.S.M., B.Sc., F.I.C., M.Inst.M.M., and J. E. Clennell, B.Sc., Assoc. Inst.M.M. Pp. xii + 495. (London : Chapman & Hall, Ltd., 1929.) Price 30s. net.

The object of this book is stated to be to present, in a concise form, a number of recommended methods of analysis for the elements met with in metallurgical work.

The subject matter is divided into six parts and an appendix. The first part deals with sampling, qualitative analysis, general methods of solution and separation, and the preparation of samples ; the second includes selected methods for the determination of the elements ; the third, fourth and fifth deal with the analysis of alloys, ores, slags, refractory materials, coal, etc. ; the sixth contains a brief chapter on electrometric titration, and longer ones on mineral and spectrum analysis ; and the appendix includes standardisation tables, factors, etc.

In addition to methods of separation and determination of the elements ordinarily met with in metallurgical analyses, the authors also deal with the rare elements, and others not generally encountered or looked for by the average works analyst, and the first part of the book includes a number of tables (Nos. 14 to 23), in which schemes for the

qualitative separation of these elements are set out. These tables, although useful, should be used with discrimination, and might give unsatisfactory results if put in the hands of an inexperienced operator. There are few short cuts in rare-earth analysis, and the influence of elements upon one another is often so great that wide experience is necessary before this branch of analytical chemistry can successfully be negotiated.

Less hesitation would perhaps be felt in recommending the use of these tables if the accuracy of all the data included were unquestionable, but unfortunately this is not the case. The information regarding zirconium salts is contradictory; thus on page 320 it is stated (correctly) that zirconium is not precipitated on treatment of a solution of the element with oxalic acid, and this reaction is included in table 21 (1). According to table 16A, however, if oxalic acid is added to an acid solution containing zirconium, rare earths, etc., the zirconium is precipitated, together with the rare earth oxalates. Actually zirconium oxalate is soluble in excess of oxalic acid, and would appear in the filtrate.

The information given regarding the behaviour of zirconia, with either alkaline oxidising fluxes or potassium bisulphate, is also unreliable, and if followed might lead to serious analytical errors.

Sufficient has been said to indicate that care is necessary in the use of this book until inaccuracies have been rectified. Analysts who have had sufficient experience can make the allowances required, but to them, perhaps, the book may be unnecessary.

The portion dealing with the more common metallurgical materials and products appears to be sound, so far as it goes, although certain instructions might with advantage be amplified. The bibliographies of analytical methods are a valuable feature.

The book should be of service to those engaged in metallurgical work, but certain reactions, particularly those of the rarer elements, should be verified by reference to some standard text-books on the subject.

**ANALYTICAL CHEMISTRY.** Based on the text of F. P. Treadwell, translated, enlarged and revised by William T. Hall. Volume II. Quantitative Analysis. Pp. xiii + 848, 9 × 5½. Seventh edition. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1928.) Price 30s.

The present edition of this well-known text-book is, apart from numerous minor changes and the addition of

a students' course in analytical chemistry, substantially the same as the previous (sixth) edition.

The methods adopted are on the whole dependable. It may be remarked, however, that that suggested for the determination of thorium in monazite (p. 435), and repeated from previous editions, is not the best available, and is, in fact, liable to give erroneous results on account of the solubility of thorium oxalate in excess of ammonium oxalate.

The value of future editions of the book would be enhanced if methods for the determination of niobium and tantalum, and their separation from other elements, were included.

Little further comment is necessary, and the book still remains one of the most valuable standard text-books of analytical chemistry, and can be thoroughly recommended.

TANNING MATERIALS OF THE BRITISH EMPIRE. Pp. v + 100,  $9\frac{3}{4} \times 6\frac{1}{4}$ . (London: Imperial Institute, 1929.) Price 2s.

Four articles on the tanning materials of the British Empire were published in recent numbers of this *Bulletin*, and it was thought by the Imperial Institute Advisory Committee on Tanning Materials that it would serve a useful purpose if they were issued as a separate pamphlet. For this purpose the articles have been revised and brought up-to-date, and graphs illustrating the price fluctuations of the principal tanning materials and a bibliography have been added.

#### BOOKS RECEIVED FOR NOTICE

TEA AND TEA DEALING. By F. W. F. Staveacre. Pp. xiii + 136,  $8\frac{1}{2} \times 5\frac{1}{2}$ . (London: Sir Isaac Pitman & Sons, Ltd., 1929.) Price 7s. 6d.

THE PLANT RUSTS. By Joseph C. Arthur. Pp. v + 446,  $9 \times 6$ . (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1929.) Price 32s. 6d.

BRITISH HARDWOODS: THEIR STRUCTURE AND IDENTIFICATION. By L. Chalk, M.A., D.Phil., and B. J. Rendle, B.Sc., A.R.C.S. Pp. vi + 53,  $9\frac{3}{4} \times 7\frac{1}{4}$ . Department of Scientific and Industrial Research, Bulletin No. 3. (London: His Majesty's Stationery Office, 1929.) Price 5s.

THE CHEMISTRY OF LEATHER MANUFACTURE. By John Arthur Wilson, D.Sc. Second Edition. Volume II. Pp. 682, 9 × 6. (New York: The Chemical Catalog Company, Inc., 1929.) Price \$10.00.

HEAT INSULATORS. Report by The Engineering Committee on Experiments made at the National Physical Laboratory by Ezer Griffiths, D.Sc., F.R.S. Department of Scientific and Industrial Research, Food Investigation Special Report No. 35. Pp. viii + 96, 9½ × 6. (London: His Majesty's Stationery Office, 1929.) Price 2s. 6d.

POST-MORTEM CHANGES IN ANIMAL TISSUES—THE CONDITIONING OR RIPENING OF BEEF. By T. Moran and E. C. Smith. Department of Scientific and Industrial Research, Food Investigation Special Report No. 36. Pp. vii + 64, 9½ × 6. (London: H.M. Stationery Office, 1929.) Price 2s. net.

BULLETIN OF THE NATIONAL RESEARCH COUNCIL, Number 71. Bibliography of Bibliographies on Chemistry and Chemical Technology. First Supplement 1924-28. Compiled by Clarence J. West and D. D. Berolzheimer. Pp. 161, 9½ × 6½. (Washington: National Research Council, 1929.) Price \$1.50.

DANA'S MANUAL OF MINERALOGY. By William E. Ford. Pp. x + 476, 7½ × 4½. Fourteenth Edition. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1929.) Price 20s.

ORIGIN AND CONCLUSION OF THE PARIS PACT. By Denys P. Myers. Pp. 227, 7½ × 5½. (Boston, U.S.A.: World Peace Foundation, 1929.) Price \$2.00.

HANDBOOK OF INSTITUTIONS FOR THE SCIENTIFIC STUDY OF INTERNATIONAL RELATIONS. Compiled by the League of Nations' Institute of Intellectual Co-operation. Pp. 104, 8½ × 5. (Paris: International Institute of Intellectual Co-operation, 1929.) Price 75 cents.

## VOL. XXVII, 1929

## INDEX

*Botanical names and titles of books are printed in italics and authors' names in capitals*

	PAGE
<i>Absidia Butleri</i> disease of coconuts .. ..	393
<i>Acacia arabica</i> var. <i>Adansonii</i> ("neb-neb") pods, tanning qualities .. ..	115
<i>Acacia Verck</i> gum .. ..	378
<i>Acremonia</i> disease of coconuts .. ..	393
<i>Africa</i> .. ..	425
Africa, East, recent changes in the mining laws of .. ..	46
<i>African Dispensary Handbook</i> .. ..	434
<i>African Manual on Mining, Industry and Agriculture</i> .. ..	274
African "Sandaleen" wood .. ..	403
Africa, Portuguese East, composition of sisal hemp from .. ..	441
<i>Africa, South, Handbook for Farmers in</i> .. ..	529
Africa, South (see also Union of South Africa)	
<i>Agricultural Co-operation in the British Empire, Year Book</i> .. ..	137
<i>Agricultural Entomology</i> .. ..	264
<i>Agriculture, A Text-Book of Tropical</i> .. ..	527
<i>Albizzia Lebbeck</i> .. ..	340
<i>Aleurites Fordii</i> , experiments in Ceylon .. ..	498
"    " seeds from Kenya .. ..	10
" <i>montana</i> , experimental cultivation in Malaya .. ..	107, 386
"    spp. (see also Tung oil)	
ALEXANDER, J., <i>Colloid Chemistry; Theoretical and Applied</i> .. ..	141
<i>Alfalfa</i> .. ..	265
<i>Allanblackia Stuhlmannii</i> seeds from Tanganyika .. ..	455
ALLIER, R., <i>The Mind of the Savage</i> .. ..	537
<i>Alps, The Nappe Theory of the</i> .. ..	539
<i>Analytical Chemistry, Vol. II, Quantitative Analysis</i> .. ..	545
<i>Andropogon clandestinus</i> (see <i>Cymbopogon clandestinus</i> )	
Angora goat industry in United States .. ..	398
<i>Anogeissus latifolia</i> leaves from India, tanning value of .. ..	452
Antigua, sugar cane experiments in .. ..	205
<i>Applied Geophysics</i> .. ..	539
<i>Arenga saccharifera</i> (sugar palm) fibre, experiments in Malaya .. ..	506
<i>Artificial Silk</i> .. ..	266
Asbestos in Cyprus .. ..	224, 508



	PAGE
British Honduras, recent changes in the mining laws of ..	54
„ Solomon Islands Protectorate, recent changes in the mining laws of ..	57
„ West Indies, grapefruit culture in ..	189
„ „ „ (see also under separate islands)	
BROWN, C. B., and DEBENHAM, F., <i>Structure and Surface. A Book of Field Geology</i> ..	537
<i>Bruguiera</i> spp. bark, tanning value ..	470
Bulrush millet, experiments in Tanganyika ..	348
BÜSGEN, M., <i>The Structure and Life of Forest Trees</i> ..	535
BUSK, H. G., <i>Earth Flexures</i> ..	272
<i>Cactacées Utiles du Mexique, Les</i> ..	533
<i>Cafecira, Cultura</i> ..	531
<i>Cafetera, Colombia</i> ..	532
<i>Calopogonium mucunoides</i> ..	343
CAMARGO, ROGERIO DE, <i>Cultura Caffecira</i> ..	531
Camphor, cultivation in Dutch East Indies ..	393
Canada, recent changes in the mining laws of ..	52
<i>Carapa obovata</i> bark, tanning value ..	470
<i>Carbon, Industrial</i> ..	438
CARLYLE-GALL, C., <i>African Manual on Mining, Industry and Agriculture</i> ..	274
CARSLAW, R. MCG., <i>Four Years' Farming in East Anglia, 1923-27</i>	425
<i>Caryocar villosum</i> (piqui-a), planting in Malaya ..	388
Cassava, recent research on ..	203
<i>Cattle Management</i> ..	138
<i>Centrosema pubescens</i> , as cover crop and green manure	343, 345, 375
<i>Ceriops Candolleana</i> bark, tanning value ..	470
Ceylon, <i>Alewites Fordii</i> experiments in ..	498
„ , chaulmoogra oil experiments in ..	107, 364
„ , cocoa pests in ..	474
„ , coconut pests and diseases in ..	493
„ , green manure experiments in ..	342, 473
„ , <i>Rhizoctonia bataticola</i> in ..	346
„ , rice experiments in ..	352, 478
„ , rubber research in ..	374
„ Rubber Research Scheme, report on causes of variation in plasticity of plantation rubber ..	16
„ , sisal cultivation in ..	505
„ , soil erosion experiments in ..	342, 472
„ , soil research in ..	473
„ , sugar cane experiments in ..	481
„ , tea pests in ..	477
„ , termites in ..	347
„ , tobacco experiments in ..	506
Charcoal brickettes, experiments in Cyprus ..	377
Chaulmoogra oil, experiments in Ceylon ..	107, 364
„ „ „ „ Malaya ..	206, 492

	PAGE
<i>Chemical Engineering and Chemical Catalogue</i> .. ..	439
<i>Chemistry, Analytical, Vol. II, Quantitative Analysis</i> .. ..	545
<i>Chemistry of Leather Manufacture, Vol. I</i> .. ..	269
<i>Chemistry of Pulp and Paper-Making</i> .. ..	428
CHESTERMAN, C. C., <i>African Dispensary Handbook</i> .. ..	434
Chrome ore in Cyprus .. ..	223
"    "    "    Gold Coast .. ..	410
"    "    "    Southern Rhodesia .. ..	231
Cinchona cultivation in India .. ..	61
"    "    "    Malaya .. ..	507
<i>Cities of Australia, The</i> .. ..	260
Citrate of lime, manufacture .. ..	335
"    "    "    , production and trade .. ..	322
Citric acid, production and trade .. ..	322
<i>Citronella-Olie</i> .. ..	268
Citrus, recent research on .. ..	193, 488
CLAPPERTON, R. H., and W. HENDERSON, <i>Modern Paper-Making</i> .. ..	267
Clays, brick and tile, from Ishiogo, Nigeria .. ..	27
"    "    "    "    "    "    the Sudan .. ..	161
CLENNELL, J. E. (see NAISH, W. A.)	
<i>Clitoria cajanifolia</i> as a cover plant .. ..	473
Clove oil industry of Madagascar .. ..	394
Coal in Nigeria .. ..	102, 384
"    "    Nyasaland .. ..	225
"    "    Southern Rhodesia .. ..	234
Cocoa, recent research on .. ..	474
"    , selection and use of heavy-bearing strains .. ..	461
"    , witch broom disease in Trinidad and Tobago .. ..	103
Coconut, diseases .. ..	392
"    industry in Malaya .. ..	108
"    oil, shipment in bulk .. ..	64
"    , pollination experiments in Fiji .. ..	388
"    , recent research on .. ..	207, 493
Coffee experiments in Porto Rico .. ..	104
"    , recent research on .. ..	192
<i>Colloid Chemistry; Theoretical and Applied</i> .. ..	141
<i>Colloid Symposium Monograph</i> .. ..	141
<i>Columbia Cafetera</i> .. ..	532
<i>Commercial Handbook of the Netherlands East Indies</i> .. ..	134
<i>Co-operation in Agriculture</i> .. ..	262
<i>Co-operative Marketing, Practical</i> .. ..	263
COOTE, P. C., <i>Commercial Handbook of Netherlands East Indies</i> .. ..	134
Copper ore in Gold Coast .. ..	510
<i>Cordia Goeldiana</i> timber .. ..	340
Corundum in Southern Rhodesia .. ..	234
<i>Cotonnier (Le)</i> .. ..	427
Cotton, recent research on .. ..	82, 211, 367, 499
"    , rotation crops for .. ..	86, 94
<i>Couepia grandiflora</i> .. ..	279
Cover crops, recent research on .. ..	345, 472, 475

	PAGE
Cox, J. F., and MEGEE, C. R., <i>Alfalfa</i> .. .. .	265
<i>Crotalaria striata</i> as a cover crop .. .. .	475
<i>Cultura Cafecira</i> .. .. .	531
<i>Cymbopogon clandestinus</i> oil from India .. .. .	458
"    nov. sp. oil from India .. .. .	459
Cyprus, charcoal brickette experiments in .. .. .	377
"    , flax in .. .. .	58
"    , lavender trials in .. .. .	366
Cyprus, Malta and .. .. .	260
Cyprus, mineral resources of .. .. .	222, 507
"    , recent changes in the mining laws of .. .. .	55
<i>Dairy Bacteriology</i> .. .. .	270
DAVIS, R. A., <i>Fruit Growing in South Africa</i> .. .. .	266
DEBENHAM, F. (see BROWN, C. B.) .. .. .	
<i>Derris</i> spp. in British Malaya .. .. .	219, 507
Dhawa (see <i>Anogeissus latifolia</i> ) .. .. .	
<i>Diamond: A Descriptive Treatise</i> .. .. .	142
Diamonds in British Guiana .. .. .	99, 222
"    "    Gold Coast .. .. .	510
<i>Diatraea saccharalis</i> , parasite control of .. .. .	81
"    spp., pests of rice in Malaya .. .. .	480
<i>Dicorynia paraensis</i> timber .. .. .	472
DIGUET, LÉON, <i>Les Cactacées Utiles du Mexique</i> .. .. .	533
Dika ( <i>Irvingia gabonensis</i> ) fat .. .. .	109
Distillation of mangrove wood in Malaya .. .. .	377
"    "    wattle wood .. .. .	180
<i>Dizionario di Merceologia e di Chimica Applicata</i> .. .. .	142
<i>Dolichos biflorus</i> .. .. .	345
Dominica, manurial experiments with limes in .. .. .	193
<i>Dunbaria Heynei</i> as a cover crop .. .. .	343
Dutch East Indies, camphor cultivation in .. .. .	393
"    "    "    , sisal hemp cultivation in .. .. .	111
<i>Earth Flexures</i> .. .. .	272
<i>East Anglia, Four Years' Farming in, 1923-27</i> .. .. .	425
<i>Eastern Africa To-day</i> .. .. .	134
<i>Egypt of the Sojourner, The</i> .. .. .	260
<i>Empire and Commonwealth, Studies in Government and Self-Government in Canada</i> .. .. .	134
<i>Endiandra Palmerstoni</i> timber .. .. .	340
<i>Enterolobium cyclocarpum</i> timber .. .. .	340
<i>Entomology, Agricultural</i> .. .. .	264
<i>Eucalyptus obliqua</i> bark pulp for artificial silk .. .. .	6
" <i>saligna</i> wood pulp for paper and artificial silk .. .. .	449
" <i>tereticornis</i> leaves and flowers, distillation trials in Cyprus .. .. .	366
EVANS, A. M. (see PATTON, W. S.) .. .. .	
EVE, A. S., and KEYS, D. A., <i>Applied Geophysics</i> .. .. .	539

	PAGE
<i>Evolution and Classification of Soils</i> .. .. .	261
<i>Evolution of the Igneous Rocks, The</i> .. .. .	541
<i>Excœcaria africana</i> wood .. .. .	404
Experimental consignments of Empire produce, reports by Empire Marketing Board .. .. .	188
EYNON, L., <i>Starch : Its Chemistry, Technology and Uses</i> .. .. .	136
FAUST, O., <i>Artificial Silk</i> .. .. .	266
Federated Malay States, mineral resources of .. .. .	224, 380
"  "  "  , recent changes in the mining laws of .. .. .	54
"  "  "  (see also Malaya)	
FELL, J. R., <i>Poultry Husbandry</i> .. .. .	138
"  "  , and MACDONALD, R. A. S., <i>Cattle Management</i> .. .. .	138
<i>Fermentation, The Problem of</i> .. .. .	137
<i>Fertilisers and Manures</i> .. .. .	262
<i>Fertilisers, Theory and Practice in the Use of</i> .. .. .	435
Fibres, <i>Arenga saccharifera</i> (sugar palm) .. .. .	506
"  , Mauritius hemp .. .. .	112
"  , methods of examination .. .. .	444
"  , New Zealand hemp .. .. .	112
"  , sisal hemp .. .. .	III, 219, 396, 441, 505
"  , <i>Urena lobata</i> .. .. .	396
FICKENDEY, E., and BLOMMENDAAL, H. N., <i>Ölpalme</i> .. .. .	429
Fiji, coconut experiments in .. .. .	207, 388
"  , cotton experiments in .. .. .	211
"  , fodder research in .. .. .	192
"  , recent changes in the mining laws of .. .. .	57
FILLEY, H. C., <i>Co-operation in Agriculture</i> .. .. .	262
<i>Finland, Forest Industry of</i> .. .. .	138
<i>Finland, The Forests and Forestry of Suomi,</i> .. .. .	432
<i>Flax and Jute, Spinning, Weaving and Finishing of</i> .. .. .	428
Flax export regulations of Lithuania .. .. .	187
"  in Cyprus .. .. .	58
"  industry in Oregon .. .. .	183
Fodders, recent research on .. .. .	192, 359
<i>Fomes lamoensis</i> , oil palm disease in Malaya .. .. .	497
<i>Forest Industry of Finland</i> .. .. .	139
Forest products' research in the United Kingdom .. .. .	338
<i>Forest Trees, The Structure and Life of</i> .. .. .	535
Forestry, experiments in Somaliland .. .. .	376
<i>Forests and Forestry of Suomi, Finland</i> .. .. .	432
<i>Foundations of Silviculture upon an Ecological Basis</i> .. .. .	139
<i>Four Years' Farming in East Anglia, 1923-27</i> .. .. .	425
Frog hopper research in Trinidad .. .. .	78, 481
Fruit experiments in Somaliland .. .. .	360
<i>Fruit Growing in South Africa</i> .. .. .	266
<i>Fruit Pectin : Its Commercial Manufacture and Uses</i> .. .. .	429
FULLERTON, M. E., <i>The Australian Bush</i> .. .. .	260
<i>Fusarium cubense</i> (Panama disease of bananas) .. .. .	106

	PAGE
GALLARD, J. A. L., and STUART, M., <i>Tin: Salient Facts and Opinions</i> .. .. .	271
<i>Geology, Structure and Surface, A Book of Field</i> .. .. .	537
<i>Geophysics, Applied</i> .. .. .	539
Geranium, areas of production and market conditions .. .. .	313
"    , climatic and soil conditions .. .. .	314
"    , cultivation .. .. .	315
"    , distillation .. .. .	316
"    , harvesting .. .. .	315
"    , varieties .. .. .	314
"    , yield .. .. .	316
GHOSH, H. M., <i>The Realm of Rubber</i> .. .. .	532
GIBSON, A., <i>The Malay Peninsula and Archipelago</i> .. .. .	260
Gilbert and Ellice Islands Colony, recent changes in the mining laws of .. .. .	57
Gold Coast, cocoa investigations in .. .. .	475
"    , mineral resources of .. .. .	225, 508
"    , recent changes in the mining laws of .. .. .	48
"    , selection of heavy-bearing strains of cocoa in .. .. .	466
"    in British Guiana .. .. .	97, 222
"    Gold Coast .. .. .	509
"    Nigeria .. .. .	102, 384
"    Sierra Leone .. .. .	236
"    Somaliland .. .. .	379, 385
"    Southern Rhodesia .. .. .	228
Gram experiments in Somaliland .. .. .	361
Grapefruit culture in West Indies and Honduras .. .. .	189
"    experiments in St. Lucia .. .. .	488
Graphite in Nyasaland .. .. .	227
"    Sierra Leone .. .. .	236
Ground-nuts as rotation crop with cotton .. .. .	86, 95
"    , recent research on .. .. .	365, 495
GRUNOW, DR. W., <i>Der Kapok in der Weltwirtschaft</i> .. .. .	135
Gum, Somaliland, commercial value .. .. .	378
"    , distribution and tapping of trees .. .. .	379
Gypsum in Cyprus .. .. .	224
HAAS, P., and HILL, T. G., <i>An Introduction to the Chemistry of Plant Products, Vol. II</i> .. .. .	433
HALL, SIR A. DANIEL, <i>Fertilisers and Manures</i> .. .. .	262
HAMMER, B. W., <i>Dairy Bacteriology</i> .. .. .	270
<i>Handbook for Farmers in South Africa</i> .. .. .	529
HATCH, F. H., <i>An Introduction to the Study of Ore Deposits</i> .. .. .	271
HATSCHKE, E., <i>The Viscosity of Liquids</i> .. .. .	270
HAWLEY, R. C., <i>The Practice of Silviculture</i> .. .. .	431
HENDERSON, W. (see CLAPPERTON, R. H.)	
HERITSCH, F., <i>The Nappe Theory of the Alps</i> .. .. .	539
<i>Heteroligus claudius</i> (yam-beetle) .. .. .	203, 487
<i>Hevea brasiliensis</i> (see Para rubber)	

	PAGE
HILDEN, N. A., <i>The Forests and Forestry of Suomi, Finland</i> ..	432
HILEY, W. E., <i>The Forest Industry of Finland</i> ..	138
HILL, T. G. (see HAAAS, P.)	
HOFSTEDE, H. W., <i>Citronella Olie</i> .. ..	268
HOGARTH, A. M., <i>The Rat: A World Menace</i> ..	536
<i>Homona coffearia</i> , tea tortrix in Ceylon ..	478
<i>Hydnocarpus</i> spp., cultivation in various countries 107, 206, 364, 492	
" <i>Woodii</i> seeds from North Borneo ..	12
IANCOULESCO, A. P., <i>Les Richesses Minières de la Nouvelle Rou-</i> <i>manie</i> .. ..	436
India, <i>Anogeissus latifolia</i> from .. ..	452
"    "    cinchona cultivation in .. ..	61
"    " <i>Cymbopogon clandestinus</i> oil from .. ..	458
"    "    "    nov. sp. oil from .. ..	459
"    "    lac industry in Bengal .. ..	112
"    "    perilla seed from .. ..	277
"    "    recent changes in the mining laws of .. ..	54
"    "    wattle bark in .. ..	173
<i>Indigofera endecaphylla</i> as a cover plant .. ..	473
<i>Industrial Development of Searles Lake Brines with Equilibrium</i> <i>Data, The</i> .. ..	543
<i>Insects, Ticks, Mites and Venomous Animals of Medical and</i> <i>Veterinary Importance. Part I, Medical</i> .. ..	536
Iron ore discoveries in Gold Coast, with analyses .. ..	508
"    "    in Nyasaland .. ..	227
"    "    "    Sierra Leone .. ..	236
<i>Irrigation Projects, Success on</i> .. ..	262
<i>Irvingia gabonensis</i> (Dika) fat .. ..	109
" <i>Oliveri</i> fat .. ..	389
Ivory Coast, oil palm experiments in .. ..	110
Java, selection of heavy-bearing strains of cocoa in .. ..	465
Jelutong, recent research on .. ..	219, 375, 506
JOHNSON, F. S., <i>Eastern Africa To-Day</i> .. ..	134
<i>Juglans</i> spp., timber of .. ..	339
<i>Jute, Spinning, Weaving and Finishing of Flax and</i> .. ..	428
<i>Kapok (Der) in der Weltwirtschaft</i> .. ..	135
Kenya, fruits and seeds of <i>Aleurites Fordii</i> from .. ..	10
"    "    geranium oil in .. ..	313
"    "    peppermint oil in .. ..	310
"    "    sanidine sand from, as a puzzuolana .. ..	298
"    "    sisal boles (poles) for paper pulp from .. ..	293
"    "    "    from, composition .. ..	441
"    "    "    industry in .. ..	396
"    "    wattle bark industry in .. ..	171, 173

KEYS, D. A. (see EVE, A. S.)	
KIEWIET, C. W. DE, <i>British Colonial Policy and the South African Republic</i> .. .. .	261
KILGOUR, P. (see WOODHOUSE, T.)	
Kullan nuts ( <i>Balanites orbicularis</i> ) from Somaliland .. ..	284
Lac industry in Bengal .. .. .	112
<i>Lagerstræmia</i> sp. timber .. .. .	472
Lalona ( <i>Weinmannia Bojeriana</i> ) bark .. .. .	114
LANE, C. H. (see MCKAY, A. W.)	
<i>Lavandula</i> spp. .. .. .	317
Lavender, areas of production and market conditions .. ..	317
,, , climatic and soil conditions .. .. .	318
,, , cultivation .. .. .	318
,, , distillation .. .. .	319
,, , harvesting .. .. .	319
,, , trials in Cyprus .. .. .	366
,, , varieties .. .. .	317
,, , yield .. .. .	319
<i>Leather Manufacture, the Chemistry of, Vol. I</i> .. .. .	269
Leeward Islands, cotton experiments in Montserrat .. ..	211
,, , manurial experiments in .. .. .	191
,, , manurial experiments with limes in Dominica .. ..	193
,, , pink bollworm experiments in .. .. .	82
,, , sugar cane experiments in .. .. .	79, 205
,, , tomato experiments in Montserrat .. .. .	206
LE FLORENTIN, R., <i>Les Parfums</i> .. .. .	136
Lemon juice, production and trade .. .. .	325
,, oil, production and trade .. .. .	327
<i>Lewis's Medical and Scientific Circulating Library, Catalogue of</i> ..	440
<i>Licania rigida</i> nuts from Brazil .. .. .	279
Lima beans, experiments in Nigeria .. .. .	492
,, as rotation crop with cotton .. .. .	86
Lime, citrate of .. .. .	322, 335
,, juice, experiments in St. Lucia .. .. .	489
,, , production and trade .. .. .	325
,, oil, production and trade .. .. .	327
Limes, manurial experiments in Dominica .. .. .	193
,, , varietal trials in Dominica .. .. .	201
,, , wither-tip disease investigations in Trinidad .. ..	490
Limestone deposits in Gold Coast .. .. .	510
<i>Liquidambar Styraciflua</i> .. .. .	340
<i>Livestock Husbandry on Range and Pasture</i> .. .. .	270
Locusts in Somaliland .. .. .	346
<i>Lovoa Klaineana</i> .. .. .	340
<i>Low-Temperature Carbonisation (or Distillation) Explained</i> ..	273
<i>Luffa</i> spp. oil .. .. .	109
LUTTRINGER, A. D., <i>La Gomme de Balata</i> .. .. .	136

MACDONALD, R. A. S. (see FELL, J. R.)	
McKAY, A. W., and LANE, C. H., <i>Practical Co-operative Marketing</i>	263
Madagascar, lalona ( <i>Weinmannia Bojeriana</i> ) bark from	114
Magnesite in British Guiana	102
Maize, recent research on	348
Malaya, <i>Aleurites montana</i> cultivation in	107, 386
"    , brazil nuts in	193
"    , cassava experiments in	203
"    , chaulmoogra oil experiments in	206, 492
"    , cinchona in	507
"    , coconut experiments in	207, 494
"    , "    industry in	109
"    , coffee experiments in	192
"    , cotton experiments in	211
"    , diseases of coconut and oil palm in	392
"    , distillation of mangrove wood in	377
"    , jelutong experiments in	219, 375, 506
"    , oil palm experiments in	209, 496
"    , Para rubber seed production in	340
"    , rice investigations in	480
"    , sisal experiments in	219
"    , soil survey in	190
"    , sugar palm fibre ( <i>Arenga saccharifera</i> ) experiments in	506
"    , tanning value of mangroves of	469
"    , tea production in	478
"    , tuba root ( <i>Derris</i> ) experiments in	219, 507
"    (see also Federated Malay States)	
Malay Peninsula and Archipelago	260
Malay Peninsula, Mangrove Forests of the	432
Malta and Cyprus	260
Mandarin oil, production and trade	327
Manganese ore in British Guiana	101
"    "    Gold Coast	510
"    "    Sierra Leone	236
Mangrove Forests of the Malay Peninsula	432
Mangroves of Malaya, tanning value of	469
Mangrove wood, distillation in Malaya	377
MANTELL, C. L., <i>Industrial Carbon</i>	438
Manures, recent research on	190, 342, 473
<i>Marasmius palmivorus</i> disease of coconuts and oil palms	392
MARTIN, C., <i>Empire and Commonwealth: Studies in Government and Self-Government in Canada</i>	134
MARTIN, H., <i>The Scientific Principles of Plant Protection</i>	263
Mauritius hemp industry	112
MEERBOTT, P. B. (see STANISLAUS, I. V. S.)	
MEGEE, C. R. (see COX, J. F.)	
<i>Mentha arvensis</i>	311
" <i>piperita</i>	311
<i>Metallurgical Analysis, Select Methods of</i>	544
<i>Metopium Brownei</i> timber	340

	PAGE
Mexico, composition of sisal hemp from .. ..	441
Mica in Southern Rhodesia .. ..	235
Millet experiments in Tanganyika .. ..	349
MILLMAN, E. R. and W., <i>Mothercraft Manual</i> .. ..	434
MILNER, H. B., <i>Sedimentary Petrography</i> .. ..	538
<i>Mimosa pudica</i> in Fiji .. ..	192
<i>Mind of the Savage, The</i> .. ..	537
Mineral resources of British Guiana .. ..	96, 220
"    "    Cyprus .. ..	222, 507
"    "    Federated Malay States .. ..	224, 382
"    "    Gold Coast .. ..	225, 308
"    "    Nigeria .. ..	102, 383
"    "    Nyasaland .. ..	225
"    "    Sierra Leone .. ..	236
"    "    Somaliland .. ..	385
"    "    Southern Rhodesia .. ..	228
"    "    Uganda .. ..	236, 510
<i>Minerals in Pastures and their Relation to Animal Nutrition</i> .. ..	434
<i>Minieres de la Nouvelle Roumanie, Les Richesses</i> .. ..	436
<i>Mining, Industry and Agriculture, African Manual of</i> .. ..	274
Mining laws of the Empire, recent changes in .. ..	46
Mkani (see <i>Allanblackia Stuhlmannii</i> )	
Mlanda seeds ( <i>Sesamum angustifolium</i> ) from Tanganyika .. ..	281
<i>Modern Paper-Making</i> .. ..	267
Mohair industry in United States .. ..	398
MONSALVE, DIEGO, <i>Colombia Cafetera</i> .. ..	532
Montserrat, cotton experiments in .. ..	211
"    , tomato experiments in .. ..	206
<i>Mothercraft Manual</i> .. ..	434
<i>Motor Mechanism of Plants</i> .. ..	140
Msambo (see <i>Allanblackia Stuhlmannii</i> )	
<i>Myrtus communis</i> leaves, distillation trials in Cyprus .. ..	366
NAISH, W. A., and CLENNELL, J. E., <i>Select Methods of Metallurgical Analysis</i> .. ..	544
<i>Nappe Theory of the Alps, The</i> .. ..	539
"Neb-Neb" pods ( <i>Acacia arabica</i> var. <i>Adansonii</i> ) from Senegal .. ..	115
<i>Netherlands East Indies, Commercial Handbook of</i> .. ..	134
Newfoundland, recent changes in the mining laws of .. ..	54
New Guinea, recent changes in the mining laws of .. ..	56
NEWITT, D. M., <i>Chemical Engineering and Chemical Catalogue</i> .. ..	439
New Zealand, beech forests of .. ..	402
"    hemp industry .. ..	112
"    , memorandum on deterioration in sheep breeding in .. ..	148
"    , physical analysis of the Romney, Corriedale and Romney-Corriedale cross-bred fleeces of .. ..	150
"    , <i>Phormium tenax</i> fibre, from, for artificial silk .. ..	8
"    , recent changes in the mining laws of .. ..	57

	PAGE
<i>New Zealanders, The</i> .. .. .	260
NICHOLLS, SIR HENRY A. ALFORD, <i>A Text-Book of Tropical</i>	
<i>Agriculture</i> .. .. .	527
Nigeria, brick and tile clays from Ishiogo .. .. .	27
" , cocoa investigations in .. .. .	477
" , cotton research in .. .. .	212, 499
" , ground-nut investigations in .. .. .	495
" , mineral resources of .. .. .	102, 383
" , oil palm investigations in .. .. .	497
" , recent changes in the mining laws of .. .. .	49
" , rice experiments in .. .. .	480
" , shea nut investigations in .. .. .	498
" , soil research on .. .. .	191
" , yam beetle investigations in .. .. .	203, 487
NIGGLI, P., <i>Ore Deposits of Magmatic Origin</i> .. .. .	540
North Borneo, fruits and seeds of <i>Hydnocarpus Woodii</i> from .. .. .	12
" , , recent changes in the mining laws of .. .. .	57
<i>Nothofagus</i> spp. of New Zealand .. .. .	402
Nyasaland, cotton research in .. .. .	83
" , mineral resources of .. .. .	225
" , recent changes in the mining laws of .. .. .	47
 Oil, mineral, in British Guiana .. .. .	101
" , " , , Nigeria .. .. .	102, 384
" , " , , Somaliland .. .. .	386
" , palm, composition of oil .. .. .	391
" , , diseases .. .. .	392
" , , experiments in Ivory Coast .. .. .	110
" , , preparation of oil .. .. .	390
" , , recent research on .. .. .	209, 496
" , seeds, <i>Aleurites</i> spp. .. .. .	11, 107, 386, 393, 498
" , , <i>Allanblackia Stuhlmannii</i> .. .. .	455
" , , babassu ( <i>Orbignia Martiana</i> ) .. .. .	286
" , , coconuts .. .. .	108, 207, 389, 493
" , , ground-nuts .. .. .	365, 495
" , , chaulmoogra .. .. .	107, 206, 364, 492
" , , <i>Hydnocarpus</i> spp. .. .. .	107, 206, 364
" , , " <i>Woodii</i> .. .. .	12
" , , <i>Irvingia gabonensis</i> (Dika) .. .. .	109
" , , " spp. .. .. .	389
" , , kulan nuts ( <i>Balanites orbicularis</i> ) .. .. .	284
" , , <i>Luffa</i> spp. .. .. .	109
" , , mlenda seeds ( <i>Sesamum angustifolium</i> ) .. .. .	281
" , , oiticica nuts ( <i>Licania rigida</i> = <i>Couepia grandiflora</i> ) .. .. .	279
" , , olives .. .. .	391
" , , palm oil .. .. .	110, 209, 390, 496
" , , Para rubber seed .. .. .	340
" , , piqui-a ( <i>Caryocar villosum</i> ) .. .. .	388
" , , <i>Perilla nankinensis</i> .. .. .	277

	PAGE
Oil seeds, <i>Perilla ocymoides</i> .. .. .	277
" " , sesame .. .. .	281, 365
" " , shea nuts .. .. .	498
" " , <i>Taraktogenos Kurzii</i> .. .. .	107, 364
" " , tung oil .. .. .	11, 107, 386, 393
Oils, essential, bergamot .. .. .	327
" " , camphor .. .. .	393
" " , clove oil .. .. .	394
" " , <i>Cymbopogon clandestinus</i> .. .. .	458
" " , " nov. sp. .. .. .	459
" " , <i>Eucalyptus tereticornis</i> .. .. .	366
" " , geranium .. .. .	313
" " , lavender .. .. .	317, 366
" " , lemon .. .. .	327
" " , lime .. .. .	327
" " , mandarin .. .. .	327
" " , <i>Myrtus communis</i> .. .. .	366
" " , orange .. .. .	327
" " , patchouli .. .. .	289
" " , peppermint .. .. .	309
" " , <i>Pinus halepensis</i> .. .. .	366
" , vegetable, transportation in bulk .. .. .	63
Oiticica nuts ( <i>Licania rigida</i> ) from Brazil .. .. .	279
Olives, trials in Tunis .. .. .	391
Ölpalme .. .. .	429, 531
Orange oil, production and trade .. .. .	327
Oranges, world's production of .. .. .	190
<i>Orbignia Martiana</i> kernels from Brazil .. .. .	286
<i>Ore Deposits, An Introduction to the Study of</i> .. .. .	271
<i>Ore Deposits of Magmatic Origin</i> .. .. .	540
ORR, J. B., <i>Minerals in Pastures and their Relation to Animal Nutrition</i> .. .. .	434
<i>Oryctes rhinoceros</i> , black beetle of coconuts, in Ceylon .. .. .	493
Paka (see <i>Urena lobata</i> )	
Palestine, recent changes in the mining laws of .. .. .	54
Palm oil, composition .. .. .	391
" " , preparation .. .. .	390
" " , shipment in bulk .. .. .	69
<i>Panicum frumentaceum</i> .. .. .	349
<i>Panicum milaceum</i> .. .. .	349
<i>Paper-Making, Chemistry of Pulp and</i> .. .. .	428
Paper-making materials, bagasse .. .. .	2
" " , <i>Eucalyptus saligna</i> .. .. .	449
" " , sisal boles and poles .. .. .	293
" " , wattle wood and bark .. .. .	178
<i>Paper-Making, Modern</i> .. .. .	267
Papua, recent changes in the mining laws of .. .. .	56
Para rubber, recent research on .. .. .	374

	PAGE
Para rubber seed, utilisation of .. .. .	340
<i>Parfums, Les</i> .. .. .	136
<i>Paspalum dilatatum</i> , in Fiji .. .. .	192
<i>Passiflora foetida</i> .. .. .	345
Patchouli leaves from Seychelles .. .. .	289
PATTON, W. S., and EVANS, A. M., <i>Insects, Ticks, Mites and Venomous Animals of Medical and Veterinary Importance.</i> <i>Part I, Medical</i> .. .. .	536
<i>Pectic Substances of Plants, A Critical and Historical Study of the</i>	534
<i>Pectin, Fruit</i> .. .. .	429
<i>Pelargonium</i> spp... .. .	314
Peppermint, areas of production and market conditions ..	309
„ , cultivation .. .. .	311
„ , distillation .. .. .	312
„ , harvesting .. .. .	312
„ , production in the Empire .. .. .	309
„ , soil conditions .. .. .	311
„ , varieties .. .. .	311
„ , yield .. .. .	313
<i>Perilla nankinensis</i> oil from Manchuria .. .. .	277
<i>Perilla ocymoides</i> seed from India .. .. .	277
PETO, G., <i>Malta and Cyprus</i> .. .. .	260
„ , „ , <i>The Egypt of the Sojourner</i> .. .. .	260
<i>Petrography, Sedimentary</i> .. .. .	538
Petroleum ( <i>see Oil, mineral</i> )	
<i>Phæbe porosa</i> timber .. .. .	340
<i>Phormium tenax</i> fibre for manufacture of artificial silk ..	8
Pigeon pea as rotation crop with cotton .. .. .	87
<i>Pinus halepensis</i> leaves, distillation trials in Cyprus .. ..	366
Piqui-a ( <i>Caryocar villosum</i> ) planting in Malaya .. .. .	388
<i>Plant Products, An Introduction to the Chemistry of</i> , Vol. II	433
<i>Plant Protection, Scientific Principles of</i> .. .. .	263
Platinum in Sierra Leone .. .. .	236
<i>Polyporus ostreiformis</i> disease of palms in Malaya .. .. .	393
Porto Rico, coffee experiments in .. .. .	104
Potatoes, experiments in Somaliland .. .. .	363
„ , sweet, experiments in Uganda .. .. .	487
<i>Pottery, Handcraft, for Workshop and School</i> .. .. .	143
<i>Poultry Husbandry</i> .. .. .	138
<i>Practical Co-operative Marketing</i> .. .. .	263
<i>Precious and Semi-Precious Stones</i> .. .. .	542
<i>Pulp and Paper-Making, Chemistry of</i> .. .. .	428
Puzzuolana, sanidine sand from Kenya as a .. .. .	298
Pyrites in Cyprus .. .. .	223, 508
RAMANN, E., <i>The Evolution and Classification of Soils</i> .. ..	261
<i>Rat: A World Menace, The</i> .. .. .	536
<i>Rhizoctonia bataticola</i> in Ceylon .. .. .	346
<i>Rhizophora</i> spp. bark, tanning value .. .. .	470

	PAGE
Rhodesia, Northern, recent changes in the mining laws of ..	47
„ „ „ Southern, mineral resources of ..	238
„ „ „ „ „ recent changes in the mining laws of ..	47
„ „ „ „ „ soils of ..	235
<i>Rhyncophorus ferrugineus</i> , red weevil of coconuts, in Ceylon ..	493
Rice, recent research on ..	350, 478
ROBINSON, D. H., <i>Agricultural Entomology</i> ..	264
<i>Rocks, The Evolution of the Igneous</i> ..	541
ROOKER, W. A., <i>Fruit Pectin</i> ..	429
Rubber, causes of variation in plasticity of plantation ..	16
<i>Rubber, The Realm of</i> ..	532
RUSCHMANN, W., <i>Banane</i> ..	531
Rutile in British Guiana ..	101
<i>Sahlbergella</i> spp., pests of cocoa ..	475
St. Kitts, manurial experiments in ..	191
St. Lucia, coconut diseases in ..	494
„ „ „ „ „ grapefruit experiments in ..	488
SAMPSON, A. W., <i>Livestock Husbandry on Range and Pasture</i> ..	270
“Sandaleen” wood ..	403
Sanidine sand from Kenya as a puzzuolana ..	298
<i>Sarcocephalus</i> sp. timber ..	472
SCHOEN, M., <i>The Problem of Fermentation</i> ..	137
<i>Scientific Principles of Plant Protection</i> ..	263
<i>Searles Lake Brines, The Industrial Development of</i> ..	543
<i>Sedimentary Petrography</i> ..	538
Senegal, “neb-neb” pods ( <i>Acacia arabica</i> var. <i>Adansonii</i> ) from ..	115
Sesame, recent research on ..	365
<i>Sesamum angustifolium</i> seeds from Tanganyika ..	281
Seychelles, patchouli leaves from ..	289
Shea nuts, investigations in Nigeria ..	498
Sheep breeding in New Zealand, deterioration in ..	148
Shellac ..	112
Sierra Leone, mineral resources of ..	236
„ „ „ „ „ recent changes in the mining laws of ..	48
<i>Silk, Artificial</i> ..	266
Silk, artificial, bagasse for manufacture of ..	3
„ „ „ „ „ <i>Eucalyptus obliqua</i> (Tasmanian stringy bark) for manufacture of ..	6
„ „ „ „ „ <i>Eucalyptus saligna</i> for manufacture of ..	449
„ „ „ „ „ <i>Phormium tenax</i> fibre for manufacture of ..	8
<i>Silviculture, Foundations of, upon an Ecological Basis</i> ..	139
<i>Silviculture, The Practice of</i> ..	431
Sisal boles and poles from Kenya for paper pulp ..	293
„ „ „ „ „ hemp, composition of, from Tanganyika, Kenya, Portuguese East Africa and Mexico ..	441
„ „ „ „ „ cultivation in Dutch East Indies ..	111
„ „ „ „ „ industry in Kenya ..	396
„ „ „ „ „ recent research on ..	219, 505

	PAGE
<i>Sisal: Production and Preparation</i> .. .. .	529
SMITH, H. HAMEL, <i>Sisal: Production and Preparation</i> .. .. .	529
<i>Soap Maker's Guide, American</i> .. .. .	430
Soils, recent research on .. .. .	77, 190, 342, 472
„ , studies in Southern Rhodesia .. .. .	235
Somaliland, cover crops in .. .. .	345
„ , fodder grasses in .. .. .	359
„ , forestry experiments in .. .. .	376
„ , fruit experiments in .. .. .	360
„ , gram experiments in .. .. .	361
„ , ground-nut experiments in .. .. .	365
„ , gum, commercial value .. .. .	378
„ , „ , distribution and tapping of trees .. .. .	379
„ , kullan nuts ( <i>Balanites orbicularis</i> ) from .. .. .	284
„ , locusts in .. .. .	346
„ , mineral resources of .. .. .	385
„ , potato experiments in .. .. .	363
„ , recent changes in the mining laws of .. .. .	48
„ , sesame experiments in .. .. .	365
„ , Sorghum experiments in .. .. .	356
Sorghum, experiments in Somaliland .. .. .	356
South Africa, Fruit Growing in .. .. .	266
South-West Africa, recent changes in the mining laws of .. .. .	51
<i>Spinning, Weaving and Finishing of Flax and Jute</i> .. .. .	428
<i>Spirostachys Africana</i> wood .. .. .	404
STANISLAUS, I. V. S., and MEERBOTT, P. B., <i>American Soap Makers' Guide</i> .. .. .	430
<i>Starch; Its Chemistry, Technology and Uses</i> .. .. .	136
<i>Structure and Life of Forest Trees, The</i> .. .. .	535
<i>Structure and Surface. A Book of Field Geology</i> .. .. .	537
STUART, M., <i>Low-Temperature Carbonisation (or Distillation) Explained</i> .. .. .	273
„ „ (see also GALLARD, J. A. L.) .. .. .	
<i>Success on Irrigation Projects</i> .. .. .	262
Sudan, brick and tile clays from the .. .. .	161
Sugar cane, recent research on .. .. .	79, 205, 480
„ palm fibre ( <i>Arenga saccharifera</i> ), experiments in Malaya .. .. .	506
SUGGATE, L. S., <i>Africa</i> .. .. .	425
Sunn hemp as rotation crop with cotton .. .. .	87
<i>Surveying as Practised by Civil Engineers and Surveyors</i> .. .. .	543
SUTERMEISTER, E., <i>Chemistry of Pulp and Paper-Making</i> .. .. .	428
SUTTON, J. R., <i>Diamond: A Descriptive Treatise</i> .. .. .	142
Swaziland, cotton in .. .. .	87, 216
„ , recent changes in the mining laws of .. .. .	49
„ , tobacco growing in .. .. .	38
Tanganyika Agricultural and Industrial Exhibition .. .. .	57
„ ; <i>Allanblackia Stuhlmannii</i> seeds from .. .. .	455
„ , bean experiments in .. .. .	361

	PAGE
Tanganyika, bulrush millet experiments in .. ..	347
"    , composition of sisal hemp from .. ..	441
"    , cotton experiments in .. ..	367
"    , cover crops in .. ..	345
"    , maize experiments in .. ..	348
"    , millet experiments in .. ..	349
"    , Mlenda seeds ( <i>Sesamum angustifolium</i> ) from ..	281
"    , recent changes in the mining laws of .. ..	47
"    , rice experiments in .. ..	353
"    , Sorghum experiments in .. ..	356
"    , tea planting in .. ..	105
Tanning materials, <i>Anogeissus latifolia</i> leaves .. ..	452
"    "    , lalona bark ( <i>Weinmannia Bojeriana</i> ) .. ..	114
"    "    , mangrove bark .. ..	460
"    "    , neb-neb pods ( <i>Acacia arabica</i> var. <i>Adansonii</i> ) ..	115
"    "    , wattle bark .. ..	170, 400
<i>Tanning Materials of the British Empire</i> .. ..	546
<i>Taraktogenos Kurzii</i> , cultivation in Ceylon .. ..	107, 364
Tasmanian stringy-bark pulp, for manufacture of artificial silk ..	6
Tea planting in Tanganyika .. ..	105
"    , recent research on .. ..	477
Teak planting in Trinidad .. ..	471
TEEPLE, J. E., <i>The Industrial Development of Searles Lake Brines</i> ..	543
<i>Tephrosia Vogelii</i> , experiments as insecticide against yam beetle ..	487
<i>Terminalia superba</i> timber .. ..	340
Termites in Ceylon .. ..	347
Terra umbra in Cyprus .. ..	224
<i>Text-Book of Tropical Agriculture</i> .. ..	527
Timbers, French colonial .. ..	472
"    , teak in Trinidad .. ..	471
"    , tropical, bibliography of .. ..	404
"    , walnut .. ..	339
Tin mining in Federated Malay States .. ..	224
<i>Tin : Salient Facts and Opinions</i> .. ..	271
Tobacco growing in Swaziland .. ..	38
"    , recent research on .. ..	506
Tomatoes, experiments in Montserrat .. ..	206
TOUMEY, J. W., <i>Foundations of Silviculture upon an Ecological Basis</i> .. ..	139
Transportation of vegetable oils in bulk .. ..	63
TREADWELL, F. P., <i>Analytical Chemistry, Vol. II, Quantitative Analysis</i> .. ..	545
Trinidad, bagasse from, for paper pulp and artificial silk .. ..	I
"    , froghopper, research in .. ..	78, 461
"    , selection of heavy-bearing strains of cocoa in .. ..	461
"    , soil research in .. ..	77
"    , teak planting in .. ..	471
"    , witch-broom disease of cocoa in .. ..	103
"    , wither-tip disease of limes, investigations in .. ..	490
<i>Triplochiton scleroxylon</i> timber .. ..	472

	PAGE
<i>Tropical Agriculture, A Text-Book of</i> .. .. .	527
<i>Tropical Crops</i> .. .. .	426
Tuba root, recent research on, in Malaya .. .. .	219, 507
Tung oil, preparation in Florida .. .. .	393
„ „ (see also <i>Aleurites</i> spp.)	
Uganda, cotton investigations in .. .. .	501
„ „ <i>Hydnocarpus Wightiana</i> in .. .. .	492
„ „ mineral resources of .. .. .	236, 510
„ „ sisal experiments in .. .. .	505
„ „ sweet potato experiments in .. .. .	487
„ „ tobacco experiments in .. .. .	506
<i>Underdrainage, Principles of</i> .. .. .	144
Unfederated Malay States, recent changes in the mining laws of	55
Union of South Africa, <i>Eucalyptus saligna</i> from Zululand for paper and artificial silk .. .. .	449
„ „ „ „ „ recent changes in the mining laws of .. .. .	50
„ „ „ „ „ wattle bark industry in .. .. .	170, 172
<i>Urena lobata</i> fibre, production in Madagascar .. .. .	396
USSHER, K., <i>The Cities of Australia</i> .. .. .	260
VILLAVECCHIA, PROF. DR. G. V., <i>Dizionario di Merceologia e di</i> <i>Chimica Applicata</i> .. .. .	142
<i>Viscosity of Liquids</i> .. .. .	270
WALKER, R. D., <i>Principles of Underdrainage</i> .. .. .	144
Walnut woods .. .. .	339
Water supplies of Nigeria .. .. .	102, 384
WATSON, J. G., <i>Mangrove Forests of the Malay Peninsula</i> .. .. .	432
Wattle bark, composition of .. .. .	400
„ „ industry, present position and prospects in the Empire .. .. .	169
„ „ „ manurial experiments.. .. .	401
„ „ „ manurial value of ash.. .. .	182
„ „ „ spent, for paper-making .. .. .	178
„ „ „ utilisation of by-products .. .. .	176
„ wood, distillation of .. .. .	180
„ „ „ for paper-making .. .. .	178
„ „ „ manurial value of ash.. .. .	182
<i>Weinmannia Bojeriana</i> (lalona) bark .. .. .	115
WEINSTEIN, M., <i>Precious and Semi-Precious Stones</i> .. .. .	542
WEISER, PROF. H. B., <i>Colloid Symposium Monograph</i> .. .. .	141
WHITELAW, J., <i>Surveying as Practised by Civil Engineers and</i> <i>Surveyors</i> .. .. .	543
WIDTBOE, J. A., <i>Success on Irrigation Projects</i> .. .. .	262
WILSON, J. A., <i>Chemistry of Leather Manufacture, Vol. I</i> .. .. .	269
Witch-broom disease of cocoa in Trinidad and Tobago .. .. .	103



10

Laurel

100